VOLUME V JULY, 1922 NUMBER 4

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF THE
AMERICAN DAIRY SCIENCE ASSOCIATION

J. H. FRANDSEN, Editor
Lincoln, Nebraska

ASSOCIATE EDITORS

F. W. BOURNA, Chicago, Ill.
A. A. BORLAND, State College, Pa.
C. H. ECKLES, St. Paul, Minn.
R. C. FISHER, Storrs, Conn.
J. B. FITCH, Manhattan, Kans.
J. A. GAMBLE, College Park, Md.
E. S. GUTHRIE, Ithaca, N. Y.
H. A. HARDING, Detroit, Mich.
S. H. HARVEY, College Park, Md.
O. F. HUNZIKER, Chicago, Ill.
H. H. KILDEE, Ames, Iowa
C. W. LARSON, Dairy Div., Dept. Agri., Washington, D. C.
W. B. P. LOCKWOOD, Amherst, Mass.
M. MORTENSEN, Ames, Iowa
LEROY S. PALMER, St. Paul, Minn.
T. R. PIRTLE, Dairy Div., Dept. Agri., Washington, D. C.
C. L. ROADHOUSE, Davis, Calif.
L. A. ROGERS, Washington, D. C.
H. A. RUEHE, Urbana, Illinois
W. A. STOCKING, JR., Ithaca, N. Y.
M. R. TOLSTRUP, Clemson, So. Carolina
H. E. VAN NORMAN, Washington, D. C.
IVAN C. WELD, Washington, D. C.
G. C. WHITE, Storrs, Conn.

CONTENTS

A Comparison of Early, Medium and Late Maturing Varieties of Silage Corn for Milk Production. GEORGE C. WHITE, LEROY M. CHAPMAN, WILLIAM L. SLATE, JR., AND BENJAMIN A. BROWN 333
Studies in the Growth and Nutrition of Dairy Calves. IV. The Feed Cost of Growing Dairy Heifers. ANDREW C. MCCANDLISH 348
Yeast and Mold Counts and Their Relation to Pasteurization of Cream for Butter Making Purposes. B. A. STIRITZ 362
Laboratory Supervision of Pasteurization Plants. IRA VAUGHAN HISCOCK 372
A Note on the Weinsirl Anaerobic Spore Test for Determining Manurial Pollution of Milk. JAMES R. HUDSON AND FRED W. TANNER 377
The Relationship Between the Hydrogen-Ion Concentration and the Bacterial Content of Commercial Milk. EDWIN W. SCHULTE, ALBERTA MARX AND HAROLD J. BEAVER. 383
The Physical Analysis of Dry Milk. R. M. WASHBURN 388
A Method for the Determination of Amino Nitrogen and Ammonia in Cream and Butter. L. W. FERRIS 399
The Danger of Improperly Capped Milk Bottles. J. G. JACKLEY 406
The Milking Machine an Important Factor in Milk Quality. JAMES D. BREW 412

PUBLISHED BI-MONTHLY

WILLIAMS & WILKINS COMPANY
BALTIMORE, U. S. A.

Entered as second-class matter June 9, 1917, at the Postoffice at Baltimore, Md., under the Act of March 3, 1879
Acceptance for mailing at special rate of postage provided for in Section 1103,
[Act of October 3, 1917, authorized on July 16, 1918

Copyright 1922 by Williams & Wilkins Company

Price, net postpaid per volume { $5.00 United States, Mexico, Cuba
$5.25 Canada
$5.50 Other countries

Made in United States of America

This MARK OF SUPERIORITY will be found on all equipment for the

CITY MILK PLANT
ICE CREAM PLANT
and the CREAMERY

that is manufactured by

J. G. CHERRY COMPANY

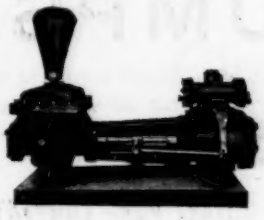
These well known Dairies are using Cherry Pasteurizing equipment—all or in part:

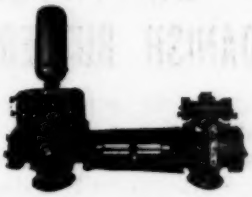
GEO. M. OYSTER CO., Washington, D. C.
CARRY MFG. CO., Washington, D. C.
FARMERS DAIRY CO., Toronto, Canada
EDMONTON CITY DAIRY, Edmonton, Canada
POLK SANT. MILK CO., Indianapolis, Ind.
UNION DAIRY CO., St. Louis, Mo.

You will be interested in the particulars of the Cherry Method of Pasteurization. Ask us!

J.G.CHERRY COMPANY

ST. PAUL, MINN. — TANA — IOWA — PEORIA, ILL.
CEDAR RAPIDS
IOWA





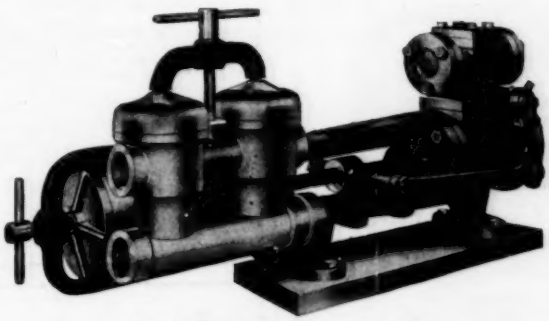
"DAVIDSON" PUMPS

have been on the market for forty years. They are built to secure economy of operation and maintenance and give long and satisfactory service.

High grade materials and first class workmanship produce "The Best Pump Built."

MILK PUMPS

BOILER FEED PUMPS **BRINE-CIRCULATING PUMPS**
TANK SUPPLY PUMPS **WASHER PUMPS**
ARTESIAN WELL PUMPS



"DAVIDSON" MILK PUMP

Send for Latest Catalog

M. T. DAVIDSON COMPANY

154 Nassau Street, New York

135 Oliver St., Boston, Mass.
617 Cherry St., Philadelphia, Pa.
1224 Granite Building, Rochester, N. Y.
604 Empire Building, Detroit, Mich.
817 Albee Building, Washington, D. C.
609 Wade Building, Cleveland, Ohio

Chr. Hansen's
DANISH BUTTER COLOR

is a strong, purely vegetable color, which can not affect the finest flavor of butter. It is always the same strength and shade, and colors butter uniformly. It is unaffected by low temperatures.

Successfully used by leading creameries and prize winners all over the world.

Chr. Hansen's Laboratory, Inc.
Little Falls, N. Y.

Western Branch—
Milwaukee, Wis.

PUMPS

A customer once gained is sure to repeat. If you are not already a user, you owe it to yourself and your business to investigate.

BLACKMER ROTARY PUMP COMPANY,
326 SHERIDAN ST. PETOSKEY, MICH.

MARSCHALL RENNET AND COLOR

STRONG PURE

THE QUALITY OF THE MARSCHALL RENNET-COLOR HAS NEVER BEEN EQUALLED

DEPENDABLE

Made in the largest and best equipped Rennet factory in America!

THE MARSCHALL DAIRY LABORATORY
MADISON WISCONSIN

BABCOCK TESTERS

See Jour. Dairy Sci., Jan. 21, 1921, page 32

INTERNATIONAL EQUIPMENT COMPANY
352 Western Ave. (Brighton)
BOSTON, MASS.

THE DAIRY LABORATORIES

20th and Market Streets, Philadelphia, Penna.
CONSULTING AND ANALYTICAL CHEMISTS
Complete Chemical and Bacteriological Analysis of Milk, Ice Cream, Dairy Products, Food, and Water
Manufacturers of
"Special colored Corrosive Sublimate Tablets for preserving Composite samples in Babcock fat Testing"
"Chlorine Solution to sterilize milk utensils"
"Sour milk Testing Solution for detecting sour milk rapidly"
"Cultures for ripening milk in making buttermilk, butter, sour cream, etc."
"FLY Spray to keep flies off dairy cattle"
Sanitary Advice and Expert Assistance
All Tests Confidential
DR. LEE H. P. MAYNARD, Milk Expert
H. C. CAMPBELL, B.S., M.D. PH.G. Chemist
DR. H. S. JOHNSON, Bacteriologist RALPH FORT, Assistant
Branches at
WASHINGTON, D. C. PITTSBURGH, PA.
BALTIMORE, MD. ST. LOUIS, MO.

IF you contemplate establishing a journal along technical, scientific or general lines, we believe you will find our organization worthy of special consideration. We undertake the development and manufacture of numerous journals.

We shall be glad to offer the services of our experts to formulate plans for establishing your journal successfully.

WILLIAMS & WILKINS COMPANY
MOUNT ROYAL AND GUILFORD AVENUES
BALTIMORE, U. S. A.

Cleanliness Defined

Just as the term "quality," when defined, includes all the factors necessary for profitable milk and milk products, so "sanitary cleanliness" resulting from the use of

Wyandotte
Dairyman's
Cleaner and Cleanser

insures a distinctive cleanliness which protects the quality of dairy products.

Such profitable, quality-insuring, cleaning results are due to a manufacturing process which makes every pound of this material uniform, not only in action, but in purity—each barrel of "Wyandotte" is like every other—and every particle is a virile cleaning agent.

Unlike other cleaning materials it contains no non-rinsing caustic, nor will this be formed in the washing process. Because it rinses easily and freely this cleaner leaves no caustic films as a source of contamination.

Uniformity, purity, and its unusual rinsing qualities make "Wyandotte" economical to use.

Indian in circle

in every package.

Order from your supply house.

It cleans clean.

The J. B. Ford Co., Sole Mnfrs., Wyandotte, Mich.

Pure Milk Problem A Simple One.

The Milk of 70% of Farmers Using Proper Methods Reaches City With Counts Under 10,000.

The problem of safe milk is not solved by bacteria counts alone, to be sure. But they are the best indication available as to the purity of milk.

They are especially indicative of the care—or lack of care—under which milk is produced by the farmer.

The importance of producing milk and cream pure on the farm is very great. It deserves much more attention than it gets. Milk with a low bacteria count can be easily produced on the average dairy farm.

So far the chief concern has been to overcome the harm done the milk at the farm—a process of renovation. This treatment does not create quality in milk—quality depends on the degree of damage caused by impurities before the milk reaches the bottling plant. There is now no excuse for accepting farmers' milk with high counts. It can be obtained with uniformly low counts with methods which reduce all organisms. This plan especially combats pathogenic organisms at their source.

As proof witness the showing of one large city where 70% of the farmers' milk is received with counts of less than 10,000 bacteria per c.c. in the can. This is the result of unprejudiced knowledge intelligently applied in the barn. One City Health Department with the courage of its convictions, appealing to open minds, has accomplished what many authorities even today claim to be impossible.

Such results are easy to accomplish. The farmers cooperate gladly—they are anxious to save losses—the methods are simple—easy to use and cost little. The B-K plan was used.

Ask us for this plan.

GENERAL LABORATORIES

127 South Dickinson St. **Madison, Wis.**

A COMPARISON OF EARLY, MEDIUM AND LATE MATURING VARIETIES OF SILAGE CORN FOR MILK PRODUCTION[1]

A REPORT OF PROGRESS

GEORGE C. WHITE AND LEROY M. CHAPMAN

Department of Dairy Husbandry

WILLIAM L. SLATE, JR., AND BENJAMIN A. BROWN

Department of Agronomy, Storrs Agricultural Experiment Station, Storrs, Connecticut

The data herein reported represents the first year of an investigation that is planned to continue for at least three years, and are, therefore, to be regarded as of a preliminary nature. However, some light seems to be thrown upon a debatable problem and it is the hope of the authors that criticims and comment will be aroused among those interested.

THE PROBLEM STATED

Silage is an important crop throughout the dairy sections of the country. In New England and the northern tier of states, where the season is short, the tendency has been to grow special varieties for silage, the seed for which is secured from more southern states producing a large green weight per acre. This has been particularly true in regions where tillable land is limited and farmers purchase much of the grain fed. On the other hand, many farmers in this region believe that earlier strains of corn are more satisfactory for silage.

It should be clearly held in mind that the problem is not "when to harvest any given variety for silage," which was formerly much discussed in the states of longer growing season. The work of several stations, particularly that of the Indiana Station (1) definitely settled that point. In the case now under discussion, the farmer must choose between a large, late maturing

[1] Contribution from the Storrs Agricultural Experiment Station.

variety that will give high total yield, but with the ears very immature, and an earlier, smaller corn that yields less tonnage but has better matured ears.

In 1914, field trials of varieties and strains of corn were begun by the agronomy department. Early results indicated that late varieties did not yield as much *dry matter* as those that would practically mature, but as data accumulated this has proven to be incorrect as shown by the table below.

Considering merely the yields of green and dry matter per acre, it would seem logical, therefore, to grow a late variety. An attempt was made to compute the feeding value of the several

TABLE 1

Yields per acre of silage corn (average of five years)

STAGE OF MATURITY	GREEN WEIGHT	DRY MATTER	WATER
	pounds	*pounds*	*per cent*
Early group Hard dough	24774	6491	73.80
Medium group Soft dough	32947	7218	78.09
Late group Kernels just forming	40648	8064	80.16

It should be borne in mind that these are distinct groups of varieties, all planted and harvested at the same time, and that they represent the range found in actual practice in New England.

silages on the basis of digestion coefficients available through the work of Lindsey and Armsby, and to use results in an equation that would include the yield per acre. This proved fruitless because, first, the coefficients are given simply as for "mature" and "immature" corn and second, these coefficients do not throw sufficient light on the "milk-producing value" of the several feeds.

It was then decided to undertake a feeding investigation to answer the following questions:

1. What is the value per ton of early, medium and late types of silage corn for milk production?

2. What is the acre value of these several types for milk production?

PLAN OF THE EXPERIMENT

The silos

Three small silos, 36 × 6 feet, were purchased and erected during the summer of 1920. They are of spruce staves, set on a concrete base without drains and are covered with separate conical, metal roofs. The inside surface is treated with a wood preserver supplied by the manufacturer of the silos.

The diameter is small to allow feeding to a small group of cows without spoilage. Normal silage can be produced in very small containers as has been shown by Eckles et al. (2), Newton (3), and Westover and Garver (4). No difficulty was met in this respect, excellent silage resulting in all cases.

The silage

Three types of corn were used, early (Pride of the North), medium (Leaming) and late (Eureka). These were planted on May 28, 1920, as part of a large field of corn on the college farm and at cutting time, October 4, were sampled and analyzed with the following results:

TABLE 2

SILO-VARIETY	STAGE OF MATURITY	ANALYSIS IN PERCENTAGE						
		Water	Dry matter	Ash	Crude protein	Crude fiber	N-free extract	Fat
A. Pride of the North (early)	Ripe, basal leaves dry	70.22	29.78	1.17	2.48	5.87	19.44	0.81
B. Leaming (medium)	Soft dough	75.04	24.96	0.99	1.92	5.33	16.16	0.56
C. Eureka (late)	Early milk	79.49	20.51	0.89	1.28	5.95	11.97	0.29

It will be noted that the corn used for filling these silos is somewhat higher in dry matter and lower in per cent water than the five year averages for the types given in table 1, due largely to season. During the three weeks following filling of the silos, the one containing the late corn lost considerable juice, the medium lost very little and the early practically none.

The silage feeding

Silage, in the usual ration, is only one of the food components and comprises, in nutrients supplied, approximately one third of the total amount consumed. Other investigators who were consulted, while planning this experiment, felt that the difference

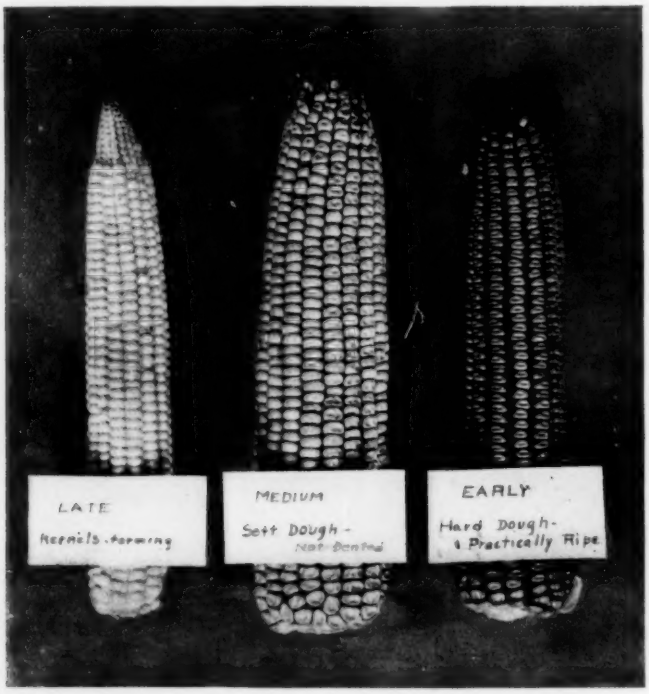


FIG. 1. LEFT TO RIGHT: EUREKA, LEAMING AND PRIDE OF THE NORTH PHOTOGRAPHED AT TIME OF ENSILING

The Leaming in center was not dented although having a suggestion of being dented due to slight loss of moisture before being photographed.

in feeding value of silage of different maturity could not be successfully measured by a feeding trial. To have the silage contribute a considerable proportion of the total nutrients, therefore, seemed a necessity. With this in view the plan adopted called

for the feeding of 50 pounds daily to all animals that were found, in the preliminary trial, capable of eating this amount. One animal in each group was fed only 40 pounds, they being less capable of handling the larger amount cleanly. The feeding of 50 pounds daily, while high, is in line with the practice in a good many herds. In order to eliminate variables, these amounts were fed throughout the experiment.

The silage was removed twice daily from the silos in burlap bags at feeding time, weighed to each animal, and the amount recorded. The amount refused by each cow was weighed and the net weight consumed recorded for each cow. The amount refused was small and nearly identical in all three groups.

The hay feeding

The hay used was all from one uniform lot, a mixture chiefly of timothy with a small amount of redtop and clover. The quality was quite similar to a great deal of New England hay with respect to legume content, and more uniform it is believed, than hay of a higher clover content would have been.

The hay was fed soon after noon each day and four pounds was the amount fed to each animal. The small amount fed enabled the cows to consume a large quantity of silage. There was no hay refused.

The grain feeding

A grain ration that has been widely used for experimental feeding of dairy cows consists of 4 parts cornmeal, 2 parts bran and 1 part oilmeal. This ration was recommended by a committee of the American Dairy Science Association a few years ago. However, it seems better adapted for feeding with alfalfa or clover hay than with mixed hay and it does not contain cottonseed meal which is in common use as a dairy feed in the East.

For this experiment a ration consisting of 3 parts cornmeal, 3 parts wheat bran, and 2 parts cottonseed meal (36 per cent protein) seemed best adapted. Such a ration supplies a good amount of protein and provided bulk and palatability; it is quite similar to the general type of New England ration and is not greatly different from the experimental ration referred to.

Applying the digestive coefficients (5) 1 pound contains 0.148 pound digestible protein and 0.7171 pound total digestible nutrients. It has a nutritive ratio of 1 to 3.805. A ration of 50 pounds of silage, 4 pounds of hay and 8 pounds of grain provides a nutritive ratio of 1 to 6.73. The same roughages with 10 pounds of grain provides a ratio of 1 to 6.38; with 12 pounds of grain, 1 to 6.13; and with 6 pounds of grain, 1 to 7.21.

The grain was fed twice daily immediately after the milking periods and preceded the feeding of the silage at about 6:30 a.m. and 5:30 p.m. The daily live weight was used as a guide for feeding the grain. When an animal showed a tendency to gain the grain was reduced either $\frac{3}{10}$ or $\frac{4}{10}$ of a pound and generally followed in two or three days by a further alteration to make a full half pound reduction. In case of loss of weight the procedure was reversed. The grain fed throughout was from one special lot mixed in a commercial plant under the direction of one of the authors.

Salting and watering

Salt was placed before the animals three times each week. Water was placed before them in the forenoon, afternoon and at night.

The analysis of the feeds and milk

The hay was sampled from each fourth bale, 2 pounds being taken from each, after the bale had been broken.

The grain was sampled at the plant from each fifth bag during the process of filling, by the official sampler of the State Experiment Station, at New Haven.

The silage was sampled from the surface of each silo every ten days. A quart fruit jar was filled during the time the silage was being removed from the silo on three consecutive days. The three days samples of each type of silage were mixed and analyzed.

A sample of the morning and night's milk from each cow was taken at ten-day intervals, composited and tested for fat and total solids by means of the Babcock test and lactometer.

The analysis of the feeds is given in the following table:

TABLE 3

Analysis of feeds *

FEED	WATER	ASH	PROTEIN	FIBER	N-FREE EXTRACT	FAT
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Hay	4.23	5.50	7.25	30.71	50.25	2.06
Mixed ration	11.67	3.44	19.44	7.01	53.26	5.18
Bran	10.92	5.06	17.44	10.62	50.15	5.81
Corn meal	16.00	1.23	8.44	2.06	68.99	3.28
Cottonseed meal	8.42	6.26	36.50	11.78	29.98	7.06
Early silage	74.26	1.24	2.46	5.87	15.34	0.80
Medium silage	74.83	1.30	2.18	5.83	15.27	0.68
Late silage	80.57	1.19	1.68	6.84	9.97	0.47

* All of the feed analyses were made by the Chemistry Department of the Connecticut Agricultural Experiment Station at New Haven, to whom our sincere thanks are due.

The silage analyses revealed that the early and the medium were very similar in composition and presumably of about equal feeding value. The medium was uniformly a little lower in protein and fat. In round numbers the late silage compared to the early was 6 per cent higher in water, slightly lower in ash, nearly 1 per cent lower in protein, 1 per cent higher in fiber, 5.5 per cent lower in nitrogen-free extract, and contained approximately half the amount of fat. Theoretically the early should have a very slightly higher feeding value than the medium and about 20 per cent higher feeding value than the late. This assumption was clearly borne out in the feeding trials.

The cows

Data concerning the experimental cows is given in table 4. The age and initial weight is based upon January 25, 1921, this being the date of the beginning of the experiment proper.

The age is given in years and months. All animals in the experiment are pure-bred except Colony. Especial attention was given to balancing the early and late groups as to size and breed.

Polly in the early group and Colony in the late, being immature could not be prevented from gaining in weight. When the grain

was reduced the milk declined rather than the weight. The fact that Polly had calved in August, 1920, and was again bred in October made her especially unsuited to this experiment, the secreting stimulus being at such low ebb that the impulse of growth could not be checked. The data from these two animals were accordingly rejected. Lute gave birth to twins and was considerably upset for some time thereafter. She was, therefore,

TABLE 4

Data concerning experimental cows

NAME	BREED	AGE	GROUP	CALVED	BRED	INITIAL WEIGHT	FINAL WEIGHT	EXTREME VARIATION IN WEIGHT FROM INITIAL	
								Weight	Date
Pansy	Holstein	6–10	Early	12/14/20	4/ 7/21	1095	1125	1125	5/4
Polly	Holstein	2–11	Early	7/ 1/20	10/10/20	956	1081	1081	5/4
Fruition	Holstein	3–11	Early	12/29/20	4/12/20	1160	1161	1124	3/5
Copper Butterfly 2d	Jersey	10–0	Early	11/23/20	1/12/21	887	909	911	4/24
Simple	Guernsey	9–4	Medium	12/23/20	3/21/21	1030	1039	1056	3/26
Corona	Holstein	10–10	Medium	9/20/21	4/ 8/21	946	948	961	3/15
Storrs Robin 2d	Jersey	8–9	Medium	11/15/20	2/26/21	887	883	908	3/25
Lute*	Guernsey	4–5	Medium	1/ 4/21	5/ 7/21				
Filene	Holstein	3–10	Late	11/19/20	1/19/21	1059	1052	1066	4/4
Colony	Holstein	2–6	Late	11/26/20	3/14/21	915	967	972	4/24
Fusion	Holstein	3–11	Late	12/27–20	3/17–21	1292	1248	1228	3/5
V. J. Storrs	Jersey	5–9	Late	12/ 8/20	1/28/21	800	809	836	3/26

* Did not start on experiment.

never placed on experiment. As a result the actual results of the experiment are, therefor, the averages of three cows per group.

Both Fruition in the early group and Fusion in the late group, having recently calved, gave some trouble in the fore part of the experiment, as a result of the attempt to hold them at constant weight. It is an interesting fact that both, at one time, were declining in weight due to too heavy feeding of grain, they not

being able to handle 15 or 16 pounds and clean up 50 pounds of silage. The result was a rejection of part of the silage and a decline in milk. A sharp cut of 3½ pounds of grain with each quickly adjusted matters.

The animals were bred without reference to the experiment as it seems certain from Eckles (6) work that the nutrients required by the fetus could have had no appreciable influence upon the results.

The weights

The plan of the experiment was based upon the conception that an animal kept at uniform weight will use its food only for maintenance and milk production. This plan reduces the factor of gain or loss of weight to the minimum. With the exception of Fusion on late silage and Fruition on early silage, in the first stages, the weights were entirely satisfactory.

The animals were weighed daily. Weighings were made between 9:00 and 10:00 a.m. and the average of the day's weight with the nine preceding days was recorded opposite the daily weight. This ten-day average was charted each day along with the daily weight, and this information provided the basis for grain feeding as described under "feeding the grain."

Type of ration for each group remained the same

The cows were kept on the same type of rations throughout. The rations were not sufficiently different in character to warrant alternating the groups. Such a procedure would also have increased the difficulties of keeping the weight uniform. With the amount of silage and hay the same throughout for each group, (the common practice in feeding) and the weight constant, the only variables would be the amount of milk produced and the amount of grain eaten.

In this plan the basic idea was to have absolute control over the animals, securing accurate results rather than assuming that the variations in each group would offset each other as when working with large numbers.

Preliminary feeding

All animals were placed upon the experimental hay and grain ration, but using the regular herd silage (Eureka) for preliminary observations. After thirty days, on this they were each given the experimental silage for ten days before the experiment proper was started. During this time they were weighed daily. The ten-day average weight was taken on January 25 as the initial weight and the ten-day average on May 5 as the final.

The results

The experiment was run one hundred days at the end of which time one of the silos was empty and the other two practically so. The average daily grain, hay and silage consumed and the protein and dry matter supplied by each is given in the following table.

TABLE 5

Pounds feed, protein and dry matter consumed per day by each group

GROUP	GRAIN			SILAGE			HAY		
	Amount	Protein	Dry matter	Amount	Protein	Dry matter	Amount	Protein	Dry matter
	pounds	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
Early	9.9725	1.9382	8.8129	44.977	1.0688	11.2322	4	0.29	3.8308
Medium	8.314	1.6158	7.3430	45.739	0.9957	11.5190	4	0.29	3.8308
Late	11.604	2.2553	10.2492	45.537	0.7322	9.0806	4	0.29	3.8308

Table 5 shows the average daily silage consumed by each group to be practically the same: Early consuming 44.977 pounds; medium consuming 45.739 pounds; and late consuming 45.537 pounds. The protein and dry matter supplied by the silage is as follows: early 1.0688 pounds protein, 11.2322 pounds dry matter; late 0.7322 pounds protein, 9.0806 pounds dry matter, giving a difference of nearly 0.3 pound of protein and 2.2 pounds dry matter, which is approximately as much protein as was supplied by two pounds of the grain ration and as much total digestible nutrients as was supplied by 3 pounds. The early group consumed an average of 9.9725 pounds of grain, the medium group 8.314 pounds and the late group 11.604 pounds per day.

The actual difference in grain eaten between the early and late groups was 1.63 pounds per day less by the early.

Table 6 shows the average daily milk production for the early group to be 28.286 pounds; the medium, 22.938 pounds; and the late 29.206 pounds revealing a very even production for the two extreme groups. In fat production the extremes are still closer the early group showing 1.0878 pounds and the late group 1.0788 pounds with the medium at 1.0455 pounds. In total solids the extremes are almost identical, showing 3.5769 pounds for the early and 3.5990 for the late with the medium at 3.1578 pounds per day. This table also gives the average weights as follows: early group, 1054.4; medium, 963.3, and late, 1046.8. It shows an average gain of 17.67 pounds for the early, 2.63 pounds for the

TABLE 6

Average daily production and live weights, per cow

GROUP	MILK	FAT	TOTAL SOLIDS	LIVE WEIGHT	
				Average weight	Gain or loss
	pounds	*pounds*	*pounds*		
Early	28.286	1.0878	3.5769	1054.4	+17.67
Medium	22.938	1.0455	3.1578	963.3	+2.33
Late	29.206	1.0788	3.5990	1046.8	−14.00

medium, and a loss of 14.00 per cent for the late. These changes in weight are extremely small and yet some significance can be attached to them in interpreting the results of the feeding values of the silage.

Table 7 gives the total dry matter, the dry matter per pound of milk, the dry matter per pound of milk solids and the dry matter in grain per pound of milk solids per day by groups. It would appear at first glance that the dry matter in the late silage was more efficient than that of the early and medium silage. However, when it is considered that the group of three on the early silage, each gained 17.67 pounds in one hundred days and that the late silage group of three lost 14 pounds each in the same period, the utilization must be considered about equalized. A striking difference in the dry matter supplied by the grain for each pound

of solids produced in the milk is indicated in the last column of the table.

The relatively high grain requirements shown in table 8 are due to the limited amount of hay fed. It is shown clearly that the milk, fat, and total solids were produced more efficiently by the early silage group than the late group. The good showing of the medium group with regard to milk prouction and especially in economy of fat and total solid yields is due to their lesser maintenance requirements. The silage analysis would place

TABLE 7

Dry matter consumed and the amount used per unit of production

GROUP	DRY MATTER PER COW PER DAY	DRY MATTER PER POUND MILK	DRY MATTER PER POUND OF SOLIDS	DRY MATTER IN GRAIN PER POUND MILK SOLIDS
	pounds			
Early	23.8759	0.8441	6.4794	2.3916
Medium	22.7928	0.9937	7.2179	2.3253
Late	23.1606	0.7930	6.2962	2.8478

TABLE 8

Production per unit of grain

GROUP	GRAIN PER 100 POUNDS MILK	MILK PER POUND GRAIN	GRAIN PER POUND FAT	GRAIN PER POUND SOLIDS
Early	35.405	2.84	8.995	2.752
Medium	35.816	2.76	[4]7.923	2.593
Late	39.780	2.54	10.838	3.249

this group a close second to the early which is indicated quite effectively by the grain requirement, 35.405 pounds being required by the early group as against 35.816 for the medium, for each 100 pounds of milk. It is striking that every animal in the early and medium groups except one Guernsey in the medium group, produced more efficiently with respect to grain consumed than the members of the late group.

Table 9 represents the values of the early silage by 100 and compares the other types on this basis, using the feeding values in table 8, the yields as determined by the agronomy department

at the Storrs Station and the silage analysis as given in table 3. Here, the medium shows up stronger than the early due, as explained, to the lesser maintenance requirements of the medium group.

The late silage corn yields 167 tons to each 100 tons of the early. In dry matter the relation stands 123 to 100, this ratio being about the same as the fat and solids production per unit of grain, but with the advantage reversed.

TABLE 9

Relation of values—early silage group expressed as unity

GROUP	GRAIN PER 100 POUNDS MILK	MILK PER POUND GRAIN	GRAIN PER POUND FAT	GRAIN PER POUND SOLIDS	YIELD PER ACRE	
					Green weight	Dry matter
Early	100	100	100	100	100 (12 tons)	100 (6500 pounds)
Medium	101	97	88	94	133 (16 tons)	111 (7200 pounds)
Late	112	88	121	118	167 (20 tons)	123 (8000 pounds)

TABLE 10

Grain saved by early and medium silage and value at two cents per pound

GROUP	PER 100 POUNDS MILK		PER 5000 POUNDS MILK	
	Amount	Value	Amount	Value
	pounds		*pounds*	
Early	4.37	$0.09	219	$4.38
Medium	3.96	0.08	196	3.92

Table 10 shows that a saving 4.37 pounds of grain, having a value of 9 cents was effected per 100 pounds of milk by the early silage. On a basis of 5000 pounds of milk produced this would make a grain saving of $4.38. The medium group shows a saving of $3.92 per 5000 pounds of milk.

SUMMARY

1. The experiment is an attempt to determine the relative economy of milk production by growing early, medium or late maturing varieties of corn for silage.

2. Late maturing varieties, under favorable conditions, will decidedly out-yield the early varieties, both in total tonnage and dry matter.

3. The varieties used to represent the three types were: Early (Pride of the North), 25.74 per cent dry matter in silage; medium (Leaming), 25.17 per cent dry matter in silage; late (Eureka), 19.43 dry matter in silage. The season allowed Leaming to mature more than usual, resulting in practically the same per cent of dry matter as Pride of the North and very similar results in the feeding tests.

4. The grain ration consisted of 3 parts corn meal, 3 parts wheat bran and 2 parts cotton seed meal (36 per cent) having a nutritive ratio of 1 to 3.805 and carrying 0.148 pound digestible protein and 0.7171 pound digestible nutrients per pound.

5. The early silage group of cows and the late group each contained two Holsteins and one Jersey and the medium group was comprised of one Jersey, one Guernsey and one Holstein. The object was especially to have the extreme groups evenly balanced throughout.

6. The feeding trial proper covered one hundred days. Thirty days preliminary feeding upon the regular herd silage and ten days upon the experimental silage preceded the experiment proper.

7. Two animals in each group received 50 pounds of silage daily, the third, of less capacity, receiving 40 pounds. The average consumption was 44.977 pounds for the early group, 45.739 for the medium group and 45.537 pounds for the late group. The dry matter furnished by the silage per day to the early group was 11.232 pounds, to the medium, 11.519 pounds, and to the late, 9.081 pounds. The hay consumed was 4 pounds each which was eaten without waste.

8. The grain was fed according to the weight of the animal, the object being to keep them at a uniform weight. By this plan most of the food was used for maintenance and production and a small, unappreciable amount for developing the fetus in early gestation. The average daily amount of grain consumed was 9.9725 pounds by the early group, 8.314 pounds by the medium, and 11.604 pounds by the late.

9. The average daily milk yield was 28.286, 22.938 and 29.206 pounds respectively, by the early, medium and late. The fat yield was 1.0878, 1.0455, and 1.0788 pounds, respectively. The

total solids yield was 3.5769, 3.1578, and 3.5990 pounds respectively.

10. The early group averaged 1054.4 pounds in weight, and gained an average of 17.67 pounds; the medium group averaged 963.3 pounds and gained 2.33 pounds each; the late group averaged 1046.8 pounds and lost an average of 14 pounds.

11. The early group consumed 35.405 pounds of grain per 100 pounds of milk; the medium group consumed 35.816 pounds; and the late group 39.78 pounds. For total solids the early group consumed 2.752 pounds of grain to each pound produced; the medium group 2.593; and the late group 3.249. The better showing made by the medium group in solids production compared to the early is due to their lesser maintenance requirements. The relatively high grain requirement per unit of production for all of the groups is due to the small hay allowance.

12. The results show a saving for 100 pounds of milk of 4.37 pounds of grain for the early group as compared with the late group. Ton for ton, these data seem to indicate greater economy of the early silage. This is further emphasized by the fact that the early group gained some in weight and the late group lost slightly.

The real test comes when the three types of corn are compared on an acre basis, or their efficiency in milk production per acre. The authors do not feel justified in making this comparison until a second feeding trial shall have been completed.

REFERENCES

(1) Jones, W. J., Jr., and Huston, H. A.: A comparison of maize at different stages of its growth. Ind. Exp. Station, Bul. No. 175, 1914.

(2) Eckles, C. H., Oshel, O. I., and Magruder, D. M.: Silage investigations. Missouri Experiment Station Research Bulletin No. 22, 1916.

(3) Newton, R.: The Quality of Silage Produced in Barrels. Journal American Society of Agronomy, 1921, xiii, No. 1.

(4) Westover, H. L., and Garver, S.: A cheap and convenient experimental silo. Journal American Society of Agronomy, 1920, xii, no. 2.

(5) Henry, W. A., and Morrison, F. B.: Feeds and feeding. Table I. 15th edition.

(6) Eckles, C. H.: The nutrients required to develop the bovine fetus. Missouri Experiment Station Research Bulletin No. 26, 1916.

(7) Armsby, H. P.: The food value of forage corn. Pennsylvania Station Report, 1892.

STUDIES IN THE GROWTH AND NUTRITION OF DAIRY CALVES

IV. THE FEED COST OF GROWING DAIRY HEIFERS

ANDREW C. McCANDLISH

Animal Husbandry, Dairy Husbandry Section, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa

Every year five to six million heifers are needed to replace the old and unproductive cows that are weeded out of the diary herds of the United States and to increase the number of cows required to augment the supply of dairy products needed by the country.

Unfortunately in too many cases little attention is given to the proper raising of the young heifers that are ultimately to take their place in the producing herds of the country. Many calves are improperly fed from birth, while in an even larger number of cases the calves are reared well until weaning time when they are turned loose to rustle for themselves. In either case, when the heifers reach producing age they tend to be stunted and are generally undernourished, unthrifty and in poor condition. Such heifers cannot be expected to do their best work when they come into the producing herd. The improper raising of heifers is a factor of great influence in causing the low average production of milk and butterfat in many of the dairy herds of today.

Many men make a practice of raising heifers and then selling them without having an idea as to the cost of production. The feed cost of raising heifers exceeds in amount all the other cost items combined and it was this fact which prompted this study.

RÉSUMÉ OF PREVIOUS WORK

Few trials are reported on the feed cost of raising dairy heifers and only one of those reported carries the heifers through to producing age. In reviewing the literature therefore, only the

studies which carry the heifers to two years of age or over are considered.

Of the three studies reported only the one carrying the heifers to producing age and one of those carrying them to two years of age include large enough numbers of animals to be of the greatest significance.

TABLE 16

Feed required by dairy heifers

	AUTHORITY		
	Bennett and Cooper (11)	Hayden (13)	Trueman (15)
Number of heifers	17	37	5
Months fed	24	Fresh at 26½	24
Feeds:			
Whole milk, pounds	342	459	445
Skim milk, pounds	3165	3330	2953
Grain, pounds	547	1710	737
Dry roughage, pounds	2649	2634	3145
Silage and soiling pounds	3603	4042	2938
Pasture, days	294	322	300

EXPERIMENTAL WORK

The data reported here is obtained from a record of the growth and feed consumption of a group of 40 heifers grown to producing age on the Iowa State College Dairy Farm, in the years 1916 to 1921, inclusive. They all ultimately entered the producing herd.

Purebred and grade heifers of the Holstein, Guernsey and Jersey breeds and purebred Ayrshires are included. No attempt is made to determine breed distinctions as the lots would be much too small for that purpose. An effort was made, however, to determine the difference in feed cost of production of heifers that were dropped in fall and winter on the one hand, and those that were dropped in spring and summer on the other hand. Winter calves were taken to be those dropped between October 1 and March 31, while summer calves were considered to be those dropped between April 1 and September 30.

The calves used in this work were being raised to come into the producing herd and were kept under normal conditions. All were allowed to run with their dams for a few days after birth and were then put on whole milk which was fed for periods longer than is generally considered most economical. Gradually all calves were changed over to skim milk instead of whole milk. The skim milk was also fed for a considerable period. As a consequence it will be found that a large number of the calves were receiving whole milk up to near six months of age and skim milk for another period of about six months. In one case whole milk was fed after six months of age and skim milk after one year of age. This shows up in small amounts in the averages.

TABLE 17

Animals used

BREED	WINTER CALVES		SUMMER CALVES		ALL CALVES	
	Number of animals	Per cent of total	Number of animals	Per cent of total	Number of animals	Per cent of total
Ayrshires	4	10.0	2	5.0	6	15.0
Guernseys	8	20.0	7	17.5	15	37.5
Holsteins	9	22.5	3	7.5	12	30.0
Jerseys	3	7.5	4	10.0	7	17.5
Total	24	60.0	16	40.0	40	100.0

It will be seen, therefore, that the policy was one of liberal milk feeding and concentrates were also allowed in greater proportions than are generally provided. The feeding of grain was started at about a few weeks of age and was allowed liberally when needed. The same holds true for alfalfa hay. Only relatively small amounts of non-leguminous roughages were allowed and they were fed to the heifers only when no other means of disposal was available.

Pasture was allowed at all possible times as was silage though generally not in large amounts as it was usually not available in large amounts after the producing herd had been allowed for. Soiling was provided in small amounts only on special occasions. Salt and water were provided at free will at all times, with the

exception of the calves receiving milk during winter and they had access to water but twice daily.

In distinguishing between the feeding of the winter and summer calves it may be said that the winter calves were not allowed to pasture until spring, while the summer calves were generally a little younger when allowed to pasture. During their first summer the winter calves were allowed grain liberally and in the fall—when they were a year of age—a more liberal allowance of feed could be allowed them than was given to the summer heifers which were of younger age. In the following summer little grain was allowed in any case, but when the animals of both groups were getting ready to freshen, liberal allowances of grain were given—the winter heifers getting more than the others, as they freshened later in the year.

The practice was to have all heifers, as nearly as possible, freshen in the fall or winter but this was not always possible, due to difference in age. Consequently, it was found on studying both lots, winter- and summer-dropped heifers, that they had come to production at the same average age of twenty-nine months. Throughout this study, calendar months are not used, as it has been found more convenient to consider each monthly period as thirty days; the first period beginning with the day on which the heifer was born.

On consulting the data it is found that the winter calves were 4 pounds heavier than the summer calves at birth but at the age of freshening the winter heifers had made the greater gains and on the average weighed 69 pounds more than the summer heifers at the same age. For convenience the results are combined by periods of six months. It will be found that the winter heifers do not make as good average daily gains in all periods of six months as do the summer heifers but if the average daily gains from birth up to any point be considered it will be found that the winter heifers have always made the best daily gains. At the time of freshening, twenty-nine months of age, the average daily gains from birth were 1.09 pounds for the winter heifers and 1.01 pounds for the summer heifers, or an average for all heifers of 1.05 pounds.

To keep down the size of the paper and yet preserve clarity as far as possible, the amount of concentrates fed per heifer for each period of six months is given for each group and then the total amounts for each heifer are given in cumulative form up to the time of freshening. In addition all the feeds consumed are treated in the same way.

TABLE 18

Average live weight gains per heifer

AGE	WINTER CALVES			SUMMER CALVES			ALL CALVES		
	Weight	Gain for six months	Total gain	Weight	Gain for six months	Total gain	Weight	Gain for six months	Total gain
months	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
Birth	68			64			67		
6	317	249	249	309	245	245	314	247	247
12	569	252	501	540	231	476	557	243	490
18	750	181	682	698	158	634	729	172	662
24	922	172	854	874	176	810	903	174	836
29	1010	88	942	941	67	877	982	79	915

TABLE 19

Average daily live weight gain per heifer

AGE	WINTER CALVES		SUMMER CALVES		ALL CALVES	
	For six months	For total period	For six months	For total period	For six months	For total months
months	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
0–6	1.38	1.38	1.36	1.36	1.37	1.37
6–12	1.40	1.39	1.28	1.32	1.35	1.36
12–18	1.05	1.26	0.88	1.19	0.96	1.23
18–24	0.96	1.19	0.98	1.13	0.97	1.16
24–29	0.59	1.09	0.45	1.01	0.53	1.05

The feed prices used were those current at the time of the preparation of the manuscript, November, 1921. The home produced feeds were taken at farm values and did not include cost of marketing. Purchased feeds were taken on the basis of carload lots delivered.

The pasture costs were based on results previously published by Gillette, McCandlish and Kildee (12) which showed that the

average duration of the pasturing season was 167 days in this district. Under the system of management maintained in this work it has been found that one acre of pasture will be sufficient for a heifer of one year old or over for the season. Consequently, by allowing $8.00 per acre for the pasture, which is a suitable allowance for the rental, manuring and maintenance of the

TABLE 20

Average amount of concentrates consumed by heifers by six-month periods

AGE	CRACKED CORN	HOMINY FEED	GROUND OATS	WHEAT BRAN	OIL MEAL	COTTONSEED MEAL	TOTAL
			Winter calves				
months	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
0–6	139	16	79	63	36		333
6–12	468	29	179	154	77		907
12–18	407	18	118	112	59	9	723
18–24	235	2	59	70	48	5	419
24–29	345	4	100	106	88	20	663
			Summer calves				
0–6	174	24	82	61	30		371
6–12	396	57	165	131	66		815
12–18	293	25	88	75	39	2	522
18–24	436	88	93	95	51	34	717
24–29	183	8	81	91	73		436
			All calves				
0–6	154	19	80	62	34		349
6–12	439	41	174	145	73		872
12–18	361	20	106	97	51	6	641
18–24	314	4	74	82	49	16	541
24–29	280	5	92	99	77	13	566

pasture used, it will be found that the pasture costs for a heifer of twelve months of age or over will be 5 cents per day. It was more difficult to arrive at a cost for the pasture used by younger animals but it is believed that a charge of 2½ cents per day for pasture for animals less than a year of age will be sufficient.

From the prices furnished and the amount of feed consumed by the heifers the cost of concentrates by six-month periods and

TABLE 21

Average cumulative consumption of concentrates by heifers

AGE	CRACKED CORN	HOMINY FEED	GROUND OATS	WHEAT BRAN	OIL MEAL	COTTONSEED MEAL	TOTAL
Winter calves							
months	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
0–6	139	16	79	63	36		333
0–12	607	45	258	217	113		1240
0–18	1014	63	376	329	172	9	1963
0–24	1249	65	435	399	220	14	3382
0–29	1594	69	535	505	308	34	3045
Summer calves							
0–6	174	24	82	61	30		371
0–12	570	81	247	192	96		1186
0–18	863	106	335	267	135	2	1708
0–24	1299	114	428	362	186	36	2425
0–29	1482	122	509	453	259	36	2861
All calves							
0–6	154	19	80	62	34		349
0–12	593	60	254	207	107		1221
0–18	954	80	360	304	158	6	1862
0–24	1270	84	434	386	207	22	2403
0–29	1550	89	526	485	284	35	2969

TABLE 22

Average amount of feed consumed by heifers by six-month periods

AGE	SUCKING	WHOLE MILK	SKIM MILK	CONCENTRATES	SILAGE	SOILING	PASTURE	ALFALFA HAY	CANE FODDER	CORN FODDER
Winter calves										
months	*days*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*days*	*pounds*	*pounds*	*pounds*
0–6	3.5	1459	712	333	145		21	293		
6–12		57	1386	907	420	16	57	1182	38	21
12–18			7	723	957	51	53	1405	75	152
18–24				419	605	38	130	231	32	501
24–29				663	1959	179	62	463	70	239
Summer calves										
0–6	3.5	1289	954	371	63		25	395		
6–12		26	1229	815	516	18	40	1126		
12–18				522	675		124	353	16	224
18–24				717	1739	16	54	245	202	735
24–29				436	1475	315	125	364	1	123
All calves										
0–6	3.5	1391	809	349	113		22	334		
6–12		45	1323	872	470	17	50	1159	23	13
12–18			3	641	832	31	82	984	52	181
18–24				541	1059	28	100	237	101	594
24–29				566	1765	234	87	425	41	192

TABLE 23

Average cumulative consumption of feed by heifers

AGE	SUCKING	WHOLE MILK	SKIM MILK	CONCENTRATES	SILAGE	SOILING	PASTURE	ALFALFA HAY	CANE FODDER	CORN FODDER
Winter calves										
months	*days*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*days*	*pounds*	*pounds*	*pounds*
0–6	3.5	1459	712	333	145		21	293		
0–12	3.5	1516	2098	1240	565	16	78	1475	38	21
0–18	3.5	1516	2105	1963	1522	67	131	2880	113	173
0–24	3.5	1516	2105	3382	2127	105	261	3111	145	674
0–29	3.5	1516	2105	3045	4086	284	323	3574	215	913
Summer calves										
0–6	3.5	1289	954	371	63		25	395		
0–12	3.5	1315	2183	1186	579	18	65	1521		
0–18	3.5	1315	2183	1708	1254	18	189	1874	16	224
0–24	3.5	1315	2183	2425	2993	34	243	2119	218	959
0–29	3.5	1315	2183	2861	4468	349	368	2483	219	1082
All calves										
0–6	3.5	1391	809	349	113		22	334		
0–12	3.5	1436	2132	1221	583	17	72	1493	23	13
0–18	3.5	1436	2135	1862	1415	48	154	2477	75	194
0–24	3.5	1436	2135	2403	2474	76	254	2714	176	788
0–29	3.5	1436	2135	2969	4239	310	341	3139	217	980

TABLE 24

Feed prices

FEED	PRICE PER TON
Cracked corn	$10.00
Hominy feed	20.00
Ground oats	15.00
Wheat bran	20.00
Linseed oil meal O. P.	32.00
Cottonseed meal	32.00
Alfalfa hay	12.00
Cane fodder	8.00
Corn fodder	10.00
Corn silage	4.50
Soiling	4.00
Whole milk, per 100 pounds	2.00
Skim milk, per 100 pounds	0.25
Sucking, per day	0.06
Pasture, per day	0.05

the feed cost of production of the heifers, by six-month periods and cumulative from birth to producing age have been prepared.

RESULTS OBTAINED

As has already been noted the heifers used in this study were liberally fed and so the actual feed cost of production will tend

TABLE 25

Average concentrate cost per heifer by six month periods

AGE	CRACKED CORN	HOMINY FEED	GROUND OATS	WHEAT BRAN	OIL MEAL	COTTON-SEED MEAL	TOTAL
			Winter calves				
months							
0–6	$0.70	$0.16	$0.59	$0.63	$0.58		$2.66
6–12	2.34	0.29	1.34	1.54	1.23		6.74
12–18	2.04	0.18	0.89	1.12	1.00	$0.14	5.37
18–24	1.18	0.02	0.44	0.70	0.77	0.08	3.19
24–29	1.73	0.04	0.75	1.06	1.41	0.33	5.32
			Summer calves				
0–6	$0.87	$0.24	$0.62	$0.61	$0.48		$2.82
6–12	1.98	0.57	1.24	1.31	1.06		6.16
12–18	1.47	0.25	0.66	0.75	0.62	$0.03	3.78
18–24	2.18	0.08	0.70	0.95	0.82	0.54	5.27
24–29	0.92	0.08	0.61	0.91	1.17		3.69
			All calves				
0–6	$0.77	$0.19	$0.60	$0.62	$0.54		$2.72
6–12	2.20	0.41	1.31	1.45	1.17		6.54
12–18	1.81	0.20	0.80	0.97	0.82	$0.10	4.70
18–24	1.58	0.04	0.56	0.82	0.78	0.26	4.04
24–29	1.40	0.05	0.69	0.99	1.23	0.21	4.57

to be above rather than below the general average cost of feed required for producing heifers. For the total of 40 heifers the average feed cost of raising them from birth to the time of freshening at the average age of twenty-nine months was $106.81, while the same figures for the winter and summer heifers were $109.89 and $102.43, respectively.

In view of present prices this may seem a high cost of production but it should be remembered that these heifers were fed

liberally and it is liberal feeding that pays. The man who is raising heifers to bring into his own herd cannot afford to stint them on feed as it is only where they have been well grown and liberally fed that the greatest production can be expected from them.

TABLE 28

Average feed cost per heifer by six-month periods

AGE	SUCKING	WHOLE MILK	SKIM MILK	CONCENTRATES	SILAGE	SOILING	PASTURE	ALFALFA HAY	CANE FODDER	CORN FODDER	TOTAL COST
Winter calves											
months											
0–6	$0.21	$29.18	$1.78	$2.66	$0.33		$0.53	$1.76			$36.45
6–12		1.14	3.47	6.74	0.95	$0.03	1.43	7.09	$0.13	$0.11	21.09
12–18				5.37	2.15	0.10	2.63	8.43	0.30	0.76	19.74
18–24				3.19	1.36	0.08	6.50	1.39	0.13	2.51	15.16
24–29				5.32	4.41	0.36	3.10	2.78	0.28	1.20	17.45
Summer calves											
0–6	$0.21	$25.78	$2.39	$2.82	$0.14		$0.63	$2.37			$34.34
6–12		0.52	3.07	6.16	1.16	$0.04	1.00	6.76			18.71
12–18				3.78	1.52		6.20	2.12	$0.06	$1.14	14.82
18–24				5.27	3.91	0.03	2.70	1.47	0.81	3.68	17.87
24–29				3.69	3.32	0.63	6.25	2.18	0.00	0.62	16.69
All calves											
0–6	$0.21	$27.82	$2.02	$2.72	$0.25		$0.55	$2.00			$35.57
6–12		0.90	3.31	6.54	1.06	$0.03	1.25	6.93	$0.09	$0.07	20.18
12–18			0.01	4.70	1.87	0.06	4.10	5.90	0.21	0.91	17.76
18–24				4.04	2.38	0.06	5.00	1.42	0.40	2.97	16.27
24–29				4.57	3.97	0.47	4.35	2.55	0.16	0.96	17.03

This was well illustrated in the case of work with scrubs reported by McCandlish, Gillette and Kildee (14). A number of scrubs reared under poor condition had been obtained and put with the purebred herd. Previously these anmals had been very poorly fed but when put with the purebred herd at Iowa State College they were given good feed and care. These scrubs can be divided into three age groups, heifers, four-year-olds, and mature cows, according to the age at which they reached the station.

A summary of all the records made by the animals in the three groups, after a correction for age has been made, shows that those coming as mature cows had an average production of 3168.7 pounds of milk and 153.64 pounds of butterfat, while the four-year-olds averaged 3597.7 pounds of milk and 166.36 pounds of butterfat, and the heifers 4036.1 pounds of milk and

TABLE 27

Average cumulative feed cost per heifer

AGE	SUCKING	WHOLE MILK	SKIM MILK	CONCENTRATES	SILAGE	SOILING	PASTURE	ALFALFA HAY	CANE FODDER	CORN FODDER	TOTAL COST
Winter calves											
months											
0–6	$0.21	$29.18	$1.78	$2.66	$0.32		$0.53	$1.76			$36.45
0–12	0.21	30.32	5.25	9.40	1.28	$0.03	1.96	8.85	$0.13	$0.11	57.54
0–18	0.21	30.32	5.25	14.77	3.43	0.13	4.59	17.28	0.43	0.87	77.28
0–24	0.21	30.32	5.25	17.96	4.79	0.21	11.09	18.67	0.56	3.38	92.44
0–29	0.21	30.32	5.25	23.28	9.20	0.57	14.19	21.45	0.84	4.58	109.89
Summer calves											
0–6	$0.21	$25.78	$2.39	$2.82	$0.14		$0.63	$2.37			$34.34
0–12	0.21	26.30	5.46	8.98	1.30	$0.04	1.63	9.13			53.05
0–18	0.21	26.30	5.46	12.76	2.82	0.04	7.83	11.25	$0.06	$1.14	67.87
0–24	0.21	26.30	5.46	18.03	6.73	0.07	10.53	12.72	0.87	4.82	85.74
0–29	0.21	26.30	5.46	21.72	10.05	0.70	16.78	14.90	0.87	5.44	102.43
All calves											
0–6	$0.21	$27.82	$2.02	$2.72	$0.25		$0.55	$2.00			$35.57
0–12	0.21	28.72	5.33	9.26	1.31	$0.03	1.80	8.93	$0.09	$0.07	55.75
0–18	0.21	28.72	5.34	13.96	3.18	0.09	5.90	14.83	0.30	0.98	73.51
0–24	0.21	28.72	5.34	18.00	5.56	0.15	10.90	16.25	0.70	3.95	89.78
0–29	0.21	28.72	5.34	22.57	9.53	0.62	15.25	18.80	0.86	4.91	106.81

191.21 pounds of fat. In other words, the cows that had not received good feed until they were mature, were the poorest producers and taking their production as the basis of comparison, it is found that the four-year-olds produced 14 per cent more milk and 8 per cent more fat, while the heifer group produced 27 per cent more milk and 24 per cent more butterfat. This clearly shows that heifers must be well fed from birth to give maximum yields of milk and fat when they reach producing age.

The largest items in the feed cost of raising the heifers were whole milk, concentrates and alfalfa hay, and it was in these three items only that the higher cost was found for winter than for summer hiefers, even though the feeds were charged at the same price at all times.

Whole milk is an expensive feed at all times but if heifers are to be raised well, its liberal use is justified in many cases. The winter heifers received more whole milk on the average

TABLE 28

Average feed cost per pound of live weight gain by six-month periods

AGE	WINTER CALVES	SUMMER CALVES	ALL CALVES
months	*cents*	*cents*	*cents*
0–6	14.6	14.0	14.4
6–12	8.5	8.1	8.3
12–18	10.9	9.4	10.3
18–24	8.8	10.2	9.4
24–29	19.8	24.9	21.6

TABLE 29

Average cumulative feed cost per pound of live weight gain

AGE	WINTER CALVES	SUMMER CALVES	ALL CALVES
months	*cents*	*cents*	*cents*
0–6	14.6	14.0	14.4
0–12	11.5	11.1	11.4
0–18	11.4	10.7	11.1
0–24	10.9	10.6	10.7
0–29	11.7	11.7	11.7

than did the summer calves, as they were longer in being turned to pasture. The same facts hold true for the concentrates and the alfalfa hay. Though alfalfa hay is not advocated for calves in this section, yet it was necessary to feed it to all classes of young stock, as it was grown for the milking herd and older heifers and the inclusion of clover hay production in the rotation would have rendered the farming operations more cumbersome.

It has been noted that the feed cost of growing fall- and winter-dropped calves to producing age was greater in this work than was the cost of growing spring and summer calves to producing

age, though the average age of freshening was the same for both groups, twenty-nine months and it is generaly conceded that the raising of fall and winter calves is the more profitable proposition. There are certain factors regarding weather conditions and the amount of labor available which do render the raising of fall and winter calves the better proposition but here the feed cost only will be considered.

It will be found by studying the feed cost per pound of live weight gain that for each six-month period, up to eighteen months of age, the feed cost per pound of gain was greater in the case of the winter heifers, but from that age until freshening the feed cost per pound of gain was lower in the case of the winter heifers. Of more importance, however, is the fact that from birth to freshening, at the average of twenty-nine months the average feed cost per pound of live weight gain was the same for each group—11.7 cents.

Consequently, the fall- and winter-dropped calves were the better proposition, as at the age of freshening they had reached a greater weight than the spring and summer born heifers, and had been produced at the same feed cost per pound.

SUMMARY

As a result of the study of the feed cost of growing 40 dairy heifers from birth to freshening, the following statements may be presented for consideration.

1. Of the 40 heifers studied, 24 dropped between October 1 and March 31, were classed as winter heifers, while the remaining 16, dropped between April 1 and September 30, were classed as summer heifers.

2. The average age of freshening in each lot was twenty-nine months; each month being a period of thirty days and not a calendar month.

3. The average birth weights were 68 pounds for the winter heifers, 64 pounds for the summer heifers and 67 pounds for all of the animals.

4. The average weights at freshening were 1010 pounds, 941 pounds and 982 pounds for the winter, summer and all groups

respectively, while the average live weight gains from birth to freshening for these groups were 942 pounds, 877 pounds and 915 pounds.

5. For average daily live weight gains through the trial the winter heifers led with 1.09 pounds, while the summer heifers had 1.01 pounds, and the average for all was 1.05 pounds.

6. In total feed cost of production the ranking was: winter heifers, $109.89; summer heifers, $102.43, and all heifers, $106.81 each.

7. The average feed cost per pound of increase in live weight was 11.7 cents in all groups.

REFERENCES

(11) Bennett, C. H., and Cooper, M. O. 1914 The cost of raising a dairy cow. U. S. D. A. Bul. 49.

(12) Gillette, L. S., McCandlish, A. C., and Kildee, H. H. 1919 Soiling crops for milk production. Ia. Agr. Expt. Sta. Bul. 187.

(13) Hayden, C. C. 1915 The cost of raising dairy heifers. Ohio Agr. Expt. Sta. Bul. 289.

(14) McCandlish, A. C., Gillette, L. S., and Kildee, H. H. 1919 Influence of environment and breeding in increasing dairy production. II. Ia. Agr. Expt. Sta. Bul. 188.

(15) Trueman, J. M. 1910 The cost of feeding heifers. Conn. (Storrs) Agr. Expt. Sta. Bul. 63.

YEAST AND MOLD COUNTS AND THEIR RELATION TO PASTEURIZATION OF CREAM FOR BUTTER MAKING PURPOSES[1]

B. A. STIRITZ

Dairy Department, University of Illinois, Urbana, Illinois

I. INTRODUCTION

The yeast and mold content of finished butter is considered by some men[2] who are engaged in dairy work as an index to the efficiency of pasteurization of cream for butter making purposes and to the proper handling of the cream after this important process is completed. The laboratory of the American Association of Creamery Butter Manufacturers uses the yeast and mold count as an index to efficiency. They assume that when samples of butter show a low count, the product has been manufactured efficiently. From the biological standpoint it has been found that in plants[3] producing butter with a high yeast and mold count lax methods of pasteurization and handling of cream prevail. In such plants the counts were lowered materially in the finished products by improving the process of manufacture in regard to the careful pasteurization and handling of the cream.

II. OBJECT

The purpose of this investigation was two-fold: first, to determine whether or not the yeast and mold count could be taken as an efficiency index to pasteurization and handling of cream for butter making purposes; and second, to determine the source of contamination when butter made from pasteurized cream has a high yeast and mold count.

[1] This article was prepared under the direct supervision of Dr. H. A. Ruehe and Dr. M. J. Prucha, Dairy Department, University of Illinois.

[2] Mr. F. W. Bouska and Mr. J. C. Brown (9) and Mr. T. H. Lund (4, 5, 6, 7, 8).

[3] The plants are operated by members of The American Association of Creamery Butter Manufacturers and are located in various communities according to a personal interview with Mr. F. W. Bouska.

III. LITERATURE

There is little published data on yeasts and molds in creamery butter. Mr. T. H. Lund of Ontario Agricultural College, Guelph, Ontario (Canada), has shown that the yeast and mold count in butter is influenced by efficient pasteurization and he has suggested that such a count be adopted officially in determining whether butter is made from raw or from pasteurized cream. Lund has pointed out also, that even though the pasteurization process may be efficient, the cream can be contaminated in the subsequent handling by the use of yeast and mold infected churns or other equipment (5, 6, 8).

Few, if any, yeasts and molds or their spores can survive a temperature exposure of 145°F. for thirty minutes or 185°F. for thirty seconds. Such temperature exposures are those used ordinarilly in pasteurizing cream for butter making. Both Dougherty (1) and Wells (2) have demonstrated that most yeasts are destroyed at a temperature of 61°C. (141.8°F.). Dougherty found only three yeasts which survived this temperature. Thom and Ayers (10) have shown that few molds or their spores in milk survive a temperature of 60°C. (140°F.) for thirty minutes and still less are able to withstand 62.8°C. (145°F.) for thirty minutes. Only three species of Aspergillus survived 62.8°C. for thirty minutes.

O. F. Hunziker (3) summarizes the efficiency of pasteurization in destroying yeasts and molds in butter. By this investigation, he showed that the efficiency of pasteurization in killing yeasts and molds was 78 per cent whan a temperature exposure of 165°F. for thirty seconds was used, while at 185°F. for thirty seconds or 145°F. for thirty minutes (the latter two being the methods ordinarilly used in creameries), the process was 99.9 per cent efficient.

Mr. F. W. Bouska has set the arbitrary standard of 30 as the maximum count of yeasts and molds in butter which has been made from efficiently pasteurized cream. However, a large percentage of the counts should be 10 or less (9).

The yeasts and molds, that are found in butter, include a variety of yeasts (not isolated individually) but the molds are mainly Oidia (lactis) (9).

IV. METHOD OF PROCEDURE

a. Whey agar

During the first five months of the investigation, whey agar was used as a medium for determining the yeast and mold counts. The whey agar was prepared as follows: 15 grams of shredded agar and 10 grams of "Difco" standardized bacto-peptone in 1 litre of whey. The whey was secured by adding 1 cc. of rennet extract (diluted to 40 cc. with cold water) to a gallon of skimmed milk, and after the coagulation was completed, the curd was filtered off through a double thickness of cheese cloth.

Approximately 10 cc. of the above medium was used for each petri dish, and to this 1 cc. of a sterile 1 per cent tartaric acid solution was added for the purpose of inhibiting the growth of all organisms other than yeasts and molds. However, it is possible that some Bulgaricus bacteria may grow on such medium.

b. "Malt" agar

Later in the investigation, a medium made from ordinary malt drinks (often sold under the name of "near beer") was found to be more satisfactory for yeast and mold growth than the whey agar. The "malt" agar was made as follows: 15 grams of shredded agar was added to 400 cc. of the malt drink and 600 cc. of distilled water. This was heated to boiling and held at this temperature until the agar was dissolved. The medium was acidified just previous to pouring the plates by mixing 4 cc. of a sterile 5 per cent solution of lactic acid with 100 cc. of "malt" agar. This acidity was sufficient to inhibit the growth of organisms other than yeasts and molds. This medium was similar to that used by Mr. T. H. Lund, but varied in one of its ingredients. The agar prepared by Mr. Lund contained brewery wort (8), while in this investigation, brewery wort was not obtainable and the malt drink was substituted for it.

To obtain as complete data as possible, counts were run on butters which were made from both pasteurized and raw cream. In order to determine yeast and mold counts, every step in the butter making process was plated. In the case of the butter made from unpasteurized cream, counts were made on raw cream and butter. In the case of pasteurized cream, plates were made from raw cream, pasteurized cream, ripened cream, butter, buttermilk and starter. In all cases, except the butter, 1 cc. of the sample was plated by the ordinary procedure for using petri dishes. In the case of the butter, it was melted to the constituency of thick cream and 1 cc. was used for each count. The most rapid and luxurious growth of yeasts and molds was obtained by incubating the plates at 30°C. for a period of five days.

The sample of the raw cream was taken from the vat just previous to pasteurization. After the entire volume of cream was pasteurized, the cream in the vat was agitated and a sample was taken for plating. After pasteurization, the cream was cooled to 70°F. and 10 per cent starter was added. It was held at this temperature for one and one half to two hours and then the cream was cooled to the churning temperature and held over night. A sample of this ripened cream was taken just previous to churning. When the churning was completed and the butter worked, a representative sample (some butter from various parts of the churn) was taken and the plates were made. The sample of buttermilk was drawn from the gate of the churn immediately after the butter granules had gathered. In the case of the starter, the sample was taken after the starter was mixed thoroughly by stirring, and previous to its addition to the pasteurized cream. All of the above liquid samples were taken by using a sterile 100-cc. pipette. A sterile spoon was used for sampling the butter. The samples were placed in sterile ground-glass-stoppered bottles of 250 cc. capacity.

For the purpose of checking up on yeast and mold infected churns, the following procedure was carried out with three large churns (600 and 1000 pounds capacity) of the type used in commercial creameries and one small power churn (75 pounds capacity). In the case of the large churns, 20 gallons of boiled

water were put in the churn and it was revolved in fast gear for five minutes. The same method was used in rinsing the small churn except that 5 gallons of boiled water were used. In each case, a sample of the boiled water was plated to obtain a count, so that the increase in the microörganism content of the water after rinsing could be taken as the increase due to yeast and mold infected churns.

Plates were made from samples of starter secured from various creameries in the State of Illinois to determine the influence of average starters as a source of contamination in pasteurized cream. Yeast and mold determinations were made on each sample.

V. DISCUSSION OF DATA

As the results in table 1 indicate, the yeast and mold content may be reduced to a small number in the cream by pasteurization, whereas the butter may show an increase. This tends to show that the yeast and mold content can not be taken as an index for efficiency in pasteurization of raw cream. The increase of yeasts and mold in butter over that in the pasteurized cream is due, no doubt to the contamination in the subsequent handling of the cream.

Although the yeast and mold content in butter cannot be taken as an efficiency index to pasteurization, the data points to the fact that it can be considered as an efficiency index to the entire butter making process. This is true if we adopt a maximum count of 30 (Mr. F. W. Bouska's standard) yeast and mold colonies as efficient. In table 1, there are only five samples of butter out of a total of twenty-five with a higher count than 30. Three of the five contained a small number of yeasts and molds above the maximum or 30. When the maximum is passed, the cause of the high count can be traced to inferior starter or to unsterile apparatus, especially to yeast and mold infected churns.

The results indicate that a large percentage of the counts in butter show a decrease over the pasteurized cream, yet the ripened cream carries a higher count than either. The buttermilk shows a decided increase over the above counts, and this tends to in-

dicate that a large number of the yeasts and molds are not incorporated in the butter but are washed out in the buttermilk.

The flash method of pasteurization (where a temperature exposure of 185°F. for thirty seconds is used) was found to be 99.9 per cent efficient in killing yeasts and molds. This compares favorably with the results obtained by Hunziker (3). The percentage of the decrease from the raw cream to the finished butter is found in table 2. The percentage of decrease in yeasts and

TABLE 1

Yeast and mold counts in pasteurized cream butter

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	NUMBER OF SAMPLES					
	Raw cream	Pasteurized cream	Ripened cream	Butter	Buttermilk	Starter
0	0	0	0	1	0	5
1–5	0	9	2	4	0	2
6–10	0	3	1	4	4	0
11–30	0	8	8	11	2	2
31–50	0	1	2	3	4	1
51–100	0	1	2	1	1	0
101–500	0	2	0	1	0	0
501–1,000	0	0	1	0	1	0
1,001–5,000	2	0	1	0	1	3
5,001–10,000	0	0	0	0	0	0
10,001–50,000	6	0	0	0	0	0
50,001–75,000	3	0	0	0	0	0
75,001–100,000	1	0	0	0	0	0
100,001–150,000	4	0	0	0	0	0
Above 150,000	9	0	0	0	0	0

molds is smaller, as a rule, than it is after pasteurization. This points directly to the fact that the cream may be efficiently pasteurized and later recontaminated.

It has been suggested by Mr. Lund that the yeast and mold counts be taken as a method for distinguishing pasteurized from unpasteurized cream butter. The results in table 1 show that cream may be efficiently pasteurized but later recontaminated. In comparing table 1 with table 3, it is shown that yeast and mold counts cannot be used effectively. Table 1 shows that cream which has been pasteurized may carry a high count in the butter.

This may be due to inefficient pasteurization but the main cause is recontamination in the subsequent handling. In table 3, it is shown that unpasteurized cream butter had a lower count of yeasts and molds than in some cases of pasteurized cream butter.

TABLE 2

Yeast and mold reduction

PERCENTAGE RANGE	NUMBER OF SAMPLES	
	Pasteurization efficiency	Decrease from raw cream to butter
99.9 and over	11	12
99.95–99.98	7	7
99.90–99.94	5	2
99.80–99.89	2	0
99.50–99.79	0	2
99.00–99.49	0	0
Under 99.00	0	2

TABLE 3

Yeast and mold counts in unpasteurized cream butter

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	YEASTS AND MOLDS	
	Raw cream	Butter
0–75	0	0
76–150	0	1
151–500	0	2
501–1,000	2	0
1,001–5,000	1	1
5,001–10,000	0	2
10,001–25,000	1	1
25,001–35,000	0	1
35,001–50,000	3	0
Above, 50,000	1	0

There is no doubt but that the churn is a source of contamination for the finished butter. It is a difficult task to rid the churn of yeasts and molds by ordinary methods, i.e. using hot water followed by steam. The churn will harbor these organisms in the pores of the wood, boxings, cracks and similar places where treatment is almost impossible.

From table 1, it can be seen that the churn is a source of contamination. The total yeast and mold count in the butter and in the buttermilk is greater than the count of the ripened cream previous to being run into the churn. This difference must be due to the churn either through direct comtamination or the breaking up of clumps by agitation. During the churning process, the agitation is sufficient to break clumps into several parts, and this is no doubt a factor in causing the large increase in yeast and mold counts in the butter and buttermilk over that in the ripened cream.

TABLE 4

Yeast and mold counts in churn rinsings

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	NUMBER OF SAMPLES OF YEASTS		NUMBER OF SAMPLES OF MOLDS		NUMBER OF SAMPLES OF INCREASE DUE TO CHURN	
	Check on water	Number in rinse water	Check on water	Number in rinse water	Yeasts	Molds
0	12	1	10	0	1	1
1–5	2	4	4	6	4	5
6–10	0	2	0	0	2	0
11–50	0	3	0	3	3	3
51–100	0	0	0	0	0	0
101–500	0	1	0	3	1	3
501–5000	0	2	0	1	2	1
Above 5000	0	1	0	1	1	1

In table 4, the results show the effect of the churn in yeast and mold contamination. In studying this table, it must be remembered that in this investigation 20 gallons of rinse water were used in a churn in which ordinarily 200 gallons of cream were churned. Therefore if the rinse water shows a count of 20 yeast and molds per cubic centimeter it would mean the addition of only 1 yeast and mold colony per cubic centimeter if 200 gallons of cream were used.

The ripened cream shows an increase of yeasts and molds over the pasteurized cream (table 1). This may have been due to any one or all of four causes: (1) vat contamination; (2) breaking up of colonies by agitation in the vat; (3) increase due to growth or multiplication; and (4) the starter used. Steaming the vat for thirty minutes apparently killed all of the organisms. At least

plates made from water which had been sterilized and then used to rinse the vat did not show a yeast or mold colony. The agitation in the vat is slow and probably has little effect in breaking up clumps of yeasts and molds. Counts made upon cream before and after agitation confirmed this opinion. After pasteurization was completed and the starter was added, the cream was cooled to 45°F. to 50°F. (depending on the season of the year) and held over night. The tendency of such a low temperature would be to inhibit multiplication of all organisms.

At first, the starter was thought to be the main source of contamination. However, the average starter is low in yeast and mold content (table 5) and plays a rather unimportant part when

TABLE 5

Yeast and mold counts in starters

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	NUMBER OF SAMPLES	
	Yeasts	Molds
0	17	11
1–3	6	12
4–7	2	3
8–12	1	0
13–18	2	1
19–25	0	1
Above 25	0	0

we consider that ordinarily only 10 per cent starter (20 gallons in 200 gallons of ripened cream) was used in the plant where this investigation was carried out. For example, if 20 gallons of starter containing 20 yeast and mold colonies per cubic centimeter are diluted to 200 gallons with cream, it would mean an addition of one colony per cubic centimeter in the cream. None of the starters plated (table 5) contained as many as 20 yeast and mold colonies per cubic centimeter and eleven contained none. This tends to show that the starter may be considered a negligible factor in contamination except in rare cases when an inferior grade of starter is used. In table 1 there are four examples of highly contaminated starter, but the butter in two cases out of the four shown will come within the standard of 30 yeast and mold colonies per cubic centimeter of butter.

VI. CONCLUSIONS

1. The yeast and mold count of finished butter cannot be taken as an efficiency index to pasteurization. However, if a standard of 30 colonies is set as the maximum count of these in the finished butter, it can be considered as an efficiency index to the entire butter making process.

2. The data point to the fact that the yeast and mold count cannot be taken as an effective method for determining whether butter is made from raw or from pasteurized cream.

3. The churn may be one of the greatest sources of contamination of the cream after pasteurization.

4. The cream may be contaminated when starter is used, but this source of yeasts and molds has little effect on the final count in the butter except in rare cases when an extremely inferior grade of starter is added to the cream.

REFERENCES

(1) DOUGHERTY, MIRIAM W.: Studies of the thermal death points of yeasts. A thesis for the degree of Master of Science in Bacteriology from the University of Illinois in June, 1920.

(2) WELLS, E. P.: The thermal death points of yeasts. Vermont Agricultural Experiment Station Bulletin No. 203.

(3) HUNZIKER, O. F.: Pasteurization in the dairy industry. The Creamery and Milk Plant Monthly, iv, no. 10, p. 11.

(4) LUND, T. H.: Yeasts and molds in butter. New York Produce Review and American Creamery Journal, xlviii (1919), no. 6, pp. 282, 284, 286.

(5) LUND, T. H.: Yeasts and molds—Influence of the churn in the yeast counts. New York Produce Review and American Creamery Journal, li (1921), no. 2, p. 510.

(6) LUND, T. H.: Yeasts in pasteurized cream. The Creamery and Milk Plant Monthly, January (1921), p. 30.

(7) LUND, T. H.: Yeasts and molds in Ontario creamery butter. A pamphlet from the bacteriological laboratories of the Ontario Agricultural College, Guelph, Ontario, Canada.

(8) LUND, T. H.: Yeasts in pasteurized cream butter and some suggestions as to their probable source. Abstracts Bacteriology (1921), no. 1, p. 11.

(9) BOUSKA, F. W., AND BROWN, J. C.: The significance of yeasts and molds in pasteurized butter. Article not published.

(10) THOM, CHAS., AND AYERS, S. H.: The effect of pasteurization on mold spores. Journal of Agricultural Research, vi, p. 163.

LABORATORY SUPERVISION OF PASTEURIZATION PLANTS

IRA VAUGHAN HISCOCK

Department of Public Health, Yale University, New Haven, Connecticut

Inspection of the dairies will undoubtedly reduce the danger of disease germs getting into milk, but the sole practical method of assurance that it shall contain no disease germs is by adopting pasteurization. The committee on milk supply of the American Public Health Association has concluded (1920) (1) that any change in the chemical composition caused by pasteurization, if there be any, is very small and that any ill effects from the use of such milk may be remedied by the addition of such common substances as orange juice and potato water. "The protection from communicable diseases that pasteurization affords older children and adults far overshadows any of the easily remedied ill effects associated with infant feeding." This committee's findings further show that of approximately 4200 pasteurization plants in the United States and Dominion of Canada, only a very limited number are controlled from a public health point of view. It has been found that pasteurization alone is insufficient in solving the safe milk problem, but that the process must be controlled by high grade supervision and frequent inspection. It is also essential that systematic inspection of producing farms be employed. Pasteurization is not intended to cover up the trail of dirty milk.

In order to insure reliable results from a pasteurization plant, it is essential that the plant be operated by men who are thoroughly familiar with all the machinery and with the process itself. It is also advisable that the machinery be inspected each day by the manager or one of his assistants, before the milk is started from the raw tank, to make certain that the pipes, vats, and other parts of the equipment have been properly cleaned. This procedure is a matter of routine in some of our modern plants. Another factor which should be given frequent attention is the

TABLE 1

Bacterial counts and percentage reductions from three pasteurization plants, by months, July, 1919 to August, 1920

MONTH	NUMBER OF SERIES OF SAMPLES	PLANT	BACTERIA PER CUBIC CENTIMETER					
			Raw	Clarified	Pasteurization tube	Reduction	Bottles	Reduction
						per cent		*per cent*
July	2	1	12,000,000	1,000,000	40,000	92.8	2,000,000	83.3
		2						
		3						
August	21	1	125,866,000	230,000,000	1,485,000	98.0	7,181,000	94.2
		2						
	2	3	150,600,000				150,000	99.8
September	15	1	5,746,000	5,813,000	142,000	97.8	416,000	
		2						
	8	3	4,404,000				3,000	99.9
October	7	1	1,788,000	1,880,000	7,000	99.9	8,000	99.9
		2						
	1	3	140,000				1,000	99.2
November	3	1	536,000	563,000	4,000	99.2	27,000	93.0
	2	2	3,400,000		22,000	99.3	27,000	99.1
		3						
December	5	1	760,000	2,425,000	3,000	99.5	10,000	90.8
	4	2	3,025,000		39,000	97.0	65,000	97.8
January	2	1	1,200,000	Clarification discontinued.	2,000	98.3	2,000	98.3
	3	2	402,000		66,000	83.5	94,000	76.6
February	3	1	830,000		2,000	99.7	5,000	99.3
	3	2	516,000		62,000	87.9	51,000	90.1
March	2	1	900,000		13,000	98.5	14,000	98.5
	5	2	633,000		17,000	97.3	9,000	98.5
April	2	1	2,100,000		8,000	99.6	4,000	99.8
	2	2	1,100,000		2,000	99.8	8,000	99.2
May	1	1	1,000,000		2,000	99.8	2,000	99.8
	1	2	800,000		500,000	37.5	400,000	50.0
June	1	1	1,000,000		2,000	99.8	2,000	99.8
	3	2	1,900,000		400,000	78.9	400,000	78.9
July	3	1	3,600,000		3,000	99.9	10,000	99.4
	3	2	2,200,000		8,000	99.6	20,000	98.6
August	2	1	990,000		2,000	99.7	2,000	99.7
	2	2	230,000		2,000	99.1	2,000	99.1

constant use and accuracy of recording thermometers. It is not sufficient to obtain a high reduction in number of bacteria; the milk must be submitted to a temperature sufficient to kill disease organisms and must be protected thereafter from recontamination. The mere fact that milk passes through a pasteurization plant is not a sufficient guarantee of safety, for improperly cleaned cans, bottles, or careless methods may lead to trouble. The findings of the author from three pasteurization plants in a southern city of about 37,000 population further illustrate the importance of pasteurization-plant inspection and supervision.

The above figures indicate that the bacterial counts for raw milk for all plants were higher in the first months of this study. The milk pasteurized in plant no. 1 for the most part, came from dealers within a radius of 20 miles. The sampling in the plant was made from the raw-mixing tank and was a composite of all the milk. Special attention to the cleaning of this tank, together with prompt cooling of the milk, resulted in lower counts from the raw tank thereafter. As would be expected, the clarified milk gave a higher count, in practically every instance, than the raw milk before passage through this machine, due in large measure, undoubtedly, to the breaking up of "clumps," which would otherwise develop into single colonies. There is also the possibility of inoculation from an improperly sterilized machine.

The pasteurization results from all plants showed the pasteurizers to be effective most of the time except in the case of plant no. 2, a coöperative creamery which received shipped milk from different parts of the state. The fact that they had no recording thermometer, coupled with the use of old machinery by careless helpers was undoubtedly responsible for the erratic results noted. After closing the plant in July, 1920, a general clean-up was instituted and additional equipment was added. Under new management the plant reopened a short time later and the succeeding results were satisfactory.

In case of dealer no. 3, whose dairy farm nearby was the source of supply, the early raw milk counts were excessive in numbers for a modern milk plant. Greater care in cleaning the milking machine, with the use of chloride of lime, according to suggestions

of Taylor of the Dairy Division, U. S. Department of Agriculture (2) together with an increase in period of sterilization of cans, produced striking results in lowering the raw milk count. The low counts recorded in September and October were maintained for the rest of the year. Recontamination of the milk after pasteurization is believed to account for the frequent increase in bacterial counts after bottling, for none of these plants pasteurized in the bottle. It is possible to obtain a noticeable difference in counts of the same lot of milk plated at the same time, as has been conclusively demonstrated in the extensive New York studies (3) supervised by the late Professor Conn. It is believed, however, that the high counts in the bottled milk of this study are the direct result of inoculation from the bottling machine, or the bottles or other sources operating after the milk left the heating tank. This idea was confirmed by special studies of equipment (4) which indicated in plant no. 1, from studies made in July and August, 1919, a possible contamination of milk from the bottling machine of from 2500 to 9000 bacteria per cubic centimeter if the machine were full, and a possible inoculation from bottles of from 20 to 600 bacteria per cubic centimeter. Results from plant no. 2 were even higher from a study of several series of six tests for each series.

The process of can sterilization was also studied and revealed interesting results. It was found that the usual time given to can sterilization was about ten seconds of exposure to live steam, and the rinse water tested from these cans showed a possible inoculation from both cans and covers of 1000 bacteria per cubic centimeter. Ordinarily, these cans received no further treatment by the dairymen before the addition of new milk.

No special study was made of bottle caps, but Smith (5) clearly demonstrated in his study of pasteurization and subsequent handling of milk that while the initial inoculation from milk bottle caps may be small, the importance of handling and of storage of the caps, especially in bulk lots, should not be overlooked.

Following our study of the mechanical features in plant no. 1, new apparatus for sterilization of equipment was installed

and careful supervision of the process instituted. This resulted in the production of a good quality of "pasteurized milk" which increased in popularity.

CONCLUSIONS

The owners of creameries and milk depots want maximum efficiency from their plants. Lack of information concerning methods or lack of supervision of important details may prevent the attainment of best results. Health department supervision should be combined with plant supervision in order that public and plant may be protected. Coöperation results in profit for both the public and the plant.

Contamination of the milk after pasteurization is a very important problem, and careful supervision should be exercised. Medical inspection of the employees in a milk plant should be carried on, and all those coming in contact with the milk after pasteurization, in the bottling, capping, etc., should be given prophylactic inoculation where this is possible. Reinfection of milk injures the results of pasteurization and may be the source of spreading disease. Pasteurization does not necessarily mean protection. Pasteurization, coupled with intelligent and consistent dairy inspection at the source, and competent supervision at the milk plant will insure safe milk.

REFERENCES

(1) Report of the Committee on Milk Supply, Sanitary Engineering Section, A. P. H. A., August, 1920.

(2) Taylor, George Barkley: The use of chlorinated lime in the sterilization of milk utensils. Eighth Annual Report of the International Association of Dairy and Milk Inspectors, 1919.

(3) Conn, H. W.: Standards for determining the purity of milk. Public Health Reports, xxx, no. 33, 1915.

(4) Hiscock, I. V.: Health Department supervision of pasteurization plants in a small city. An. Report, Int. Assoc. Dairy and Milk Insp., 1921.

(5) Smith, Russell S.: Observations on the pasteurization and subsequent handling of milk in city milk plants. Jour. Dairy Science, ii, no. 6, November, 1919.

A NOTE ON THE WEINZIRL ANAEROBIC SPORE TEST FOR DETERMINING MANURIAL POLLUTION OF MILK

JAMES R. HUDSON AND FRED W. TANNER

Department of Bacteriology, University of Illinois, Urbana, Illinois

The public is slowly being trained to demand clean milk. It is becoming more and more the function of the laboratory investigator to apply methods for determining this and from time to time to devise new methods. Among the several different methods which have recently been proposed for this purpose is the so-called anaerobic spore test as proposed by Weinzirl (1) who claimed that the test was superior to either estimations of visible dirt and enumeration of bacteria and that the simplicity of the test along with the simple apparatus required, made it very easily applied. The test according to Weinzirl was carried out as follows:

> One-half to 1 cc. of melted paraffin is placed in a 15-mm. test tube which is plugged with cotton and sterilized either by dry or moist heat. By means of a sterile pipette, 5 cc. of milk under test are then placed in the Arnold sterilizer and heated to 80°C. for from ten to fifteen minutes. This treatment melts the paraffin which rises to the surface where it hardens on cooling and forms the anaerobic seal. The heat also expels oxygen absorbed by milk thus rendering anaerobiosis more complete. All the vegetative bacteria are killed by the heat only the spore forms remaining. The tubes are then incubated for three days at 37°C. If anaerobes are present, gas will be formed which will lift the paraffin plug in the tube. Two positive out of five tubes shows excessive pollution.

While the literature on this test is not voluminous, several investigations have been reported. The only one that need be mentioned in this note is the publication of Ayers and Clemmer (2) who have given a summary of literature and report of an investigation on the same subject. They stated, "The Weinzirl test does not appear to correlate with the quantity of manure in

milk. This seems to be due both to the method of making the test and to the variation in spore content of B. enteritidis sporogenes in manure." The investigation here reported was carried out before the paper by Ayers and Clemmer was seen.

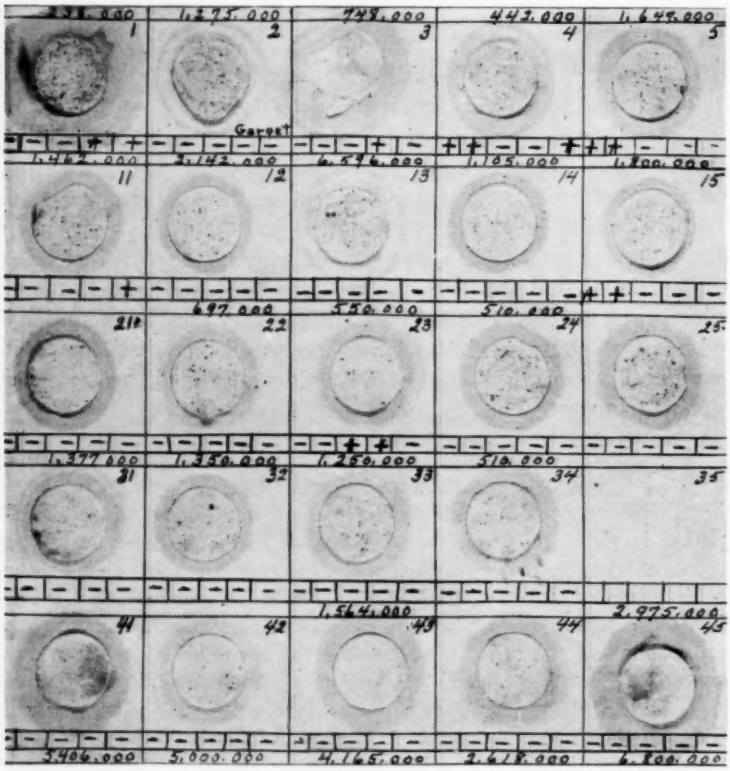


FIG. 1

In order to determine the validity of this test under practical working conditions the authors carried out an examination of over one hundred samples of milk taken at the Illinois Dairy Company at Springfield, Illinois. The samples were collected early in the spring of 1921 over a period of several days. They

were collected in 1-pint sterile bottles and sealed with sterile pasteboard caps. Ten of these samples were taken at one time and stored in the cooler at about 40°F. until they were taken to the laboratory for examination. Twenty-five samples were taken each day on four consecutive days with absolutely no at-

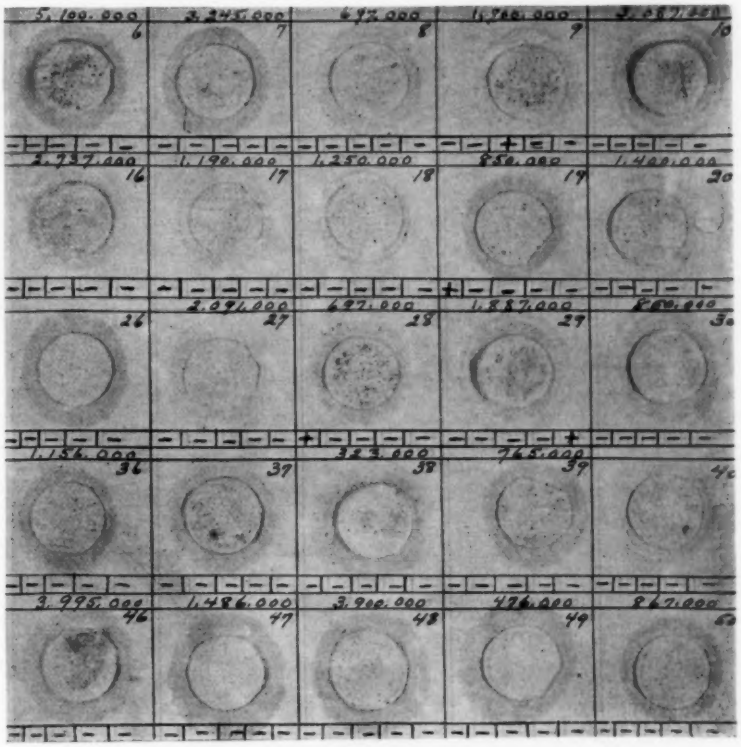


FIG. 2

tempt at selection. In order to avoid any possibility of artificial selection, milk was taken from the first twenty-five patrons which came to the creamery each day. On account of the character of the experiment we used the Frost plate count and made sediment determinations with a Wizard sediment tester since these two determinations may be taken as fair indexes of milk quality.

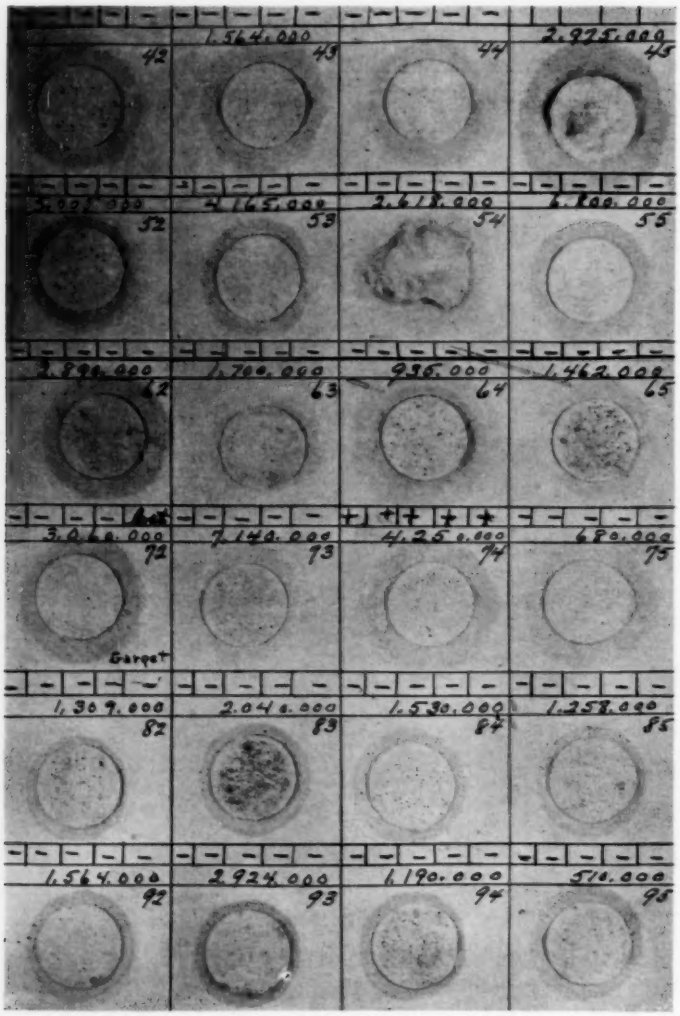

1.564.000
42
43
44
2.925.000
45
52
53
54
55
2.890.000
1.700.000
936.000
1.462.000
62
63
64
65
7.140.000
4.250.000
680.000
72
73
74
75
Target
1.309.000
2.046.000
1.530.000
1.252.000
82
83
84
85
1.564.000
2.924.000
1.190.000
510.000
92
93
94
95

FIG. 3

The spore test which we are studying in this examination was made exactly in accordance with the directions quoted above from Weinzirl's communication. The bacterial count in the spore test sample was taken from the milk before it was passed through the sediment tester.

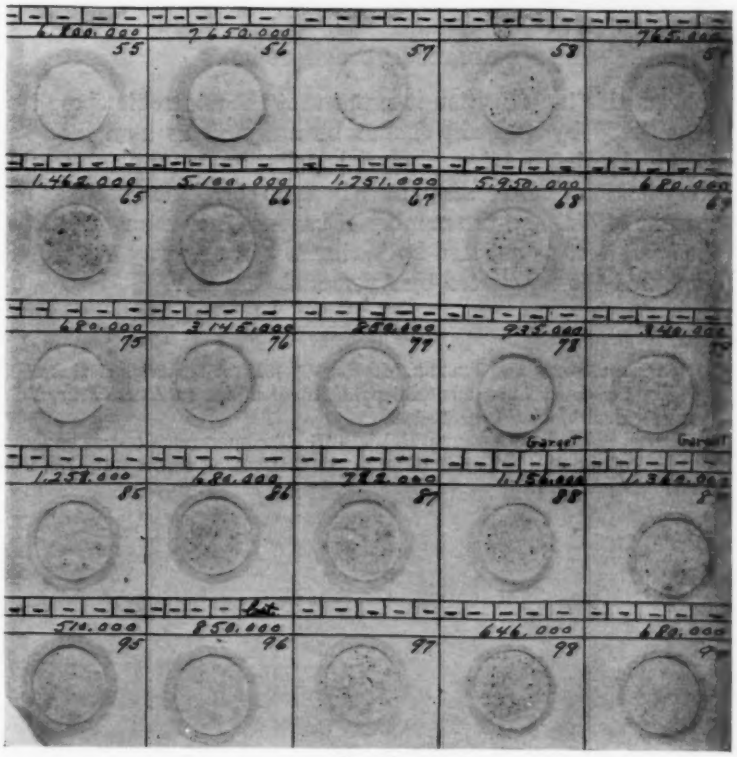


FIG. 4

Some of the results of the analyses are indicated on the illustrations accompanying this paper. An examination of these data shows that there is no correlation between the anaerobic spore test as outlined by Weinzirl and the amount of dirt in the milk, or the number of bacteria as determined by the Frost microscopic plate. For instance, sample 74 had 4,250,000 but

was negative for anaerobic spore forming bacteria. Another illustration of this is sample 46. Others could be mentioned. According to Weinzirl two positive out of five tubes used in the spore test indicated excessive pollution. In our work many samples had two or more positives but very low numbers of bacteria and very small amounts of dirt.

SUMMARY AND CONCLUSIONS

From this investigation it seems that the anaerobic spore test as outlined by Weinzirl cannot be accepted as a method for accurately determining manurial pollution in milk. In this investigation there seems to have been no correlation between the amount of dirt and the number of bacteria, nor the results from the spore test as outlined by Weinzirl. In this way our results confirmed those reported by Ayers and Clemmer.

REFERENCES

(1) WEINZIRL, JOHN, AND VELDEE, MILTON V. 1915 A bacteriological method for determining manurial pollution of milk. In Amer. Jour. Pub Health, v, no. 9, p. 862–866.

(2) AYERS, S. H., AND CLEMMER, P. W. 1921 The sporogenes test as an index of the contamination of milk. U. S. Dept. of Agric. Bull. No. 940, April 25, 1921.

THE RELATIONSHIP BETWEEN THE HYDROGEN-ION CONCENTRATION AND THE BACTERIAL CONTENT OF COMMERCIAL MILK

EDWIN W. SCHULTZ, ALBERTA MARX, AND HAROLD J. BEAVER

Department of Bacteriology and Experimental Pathology, Stanford University, California

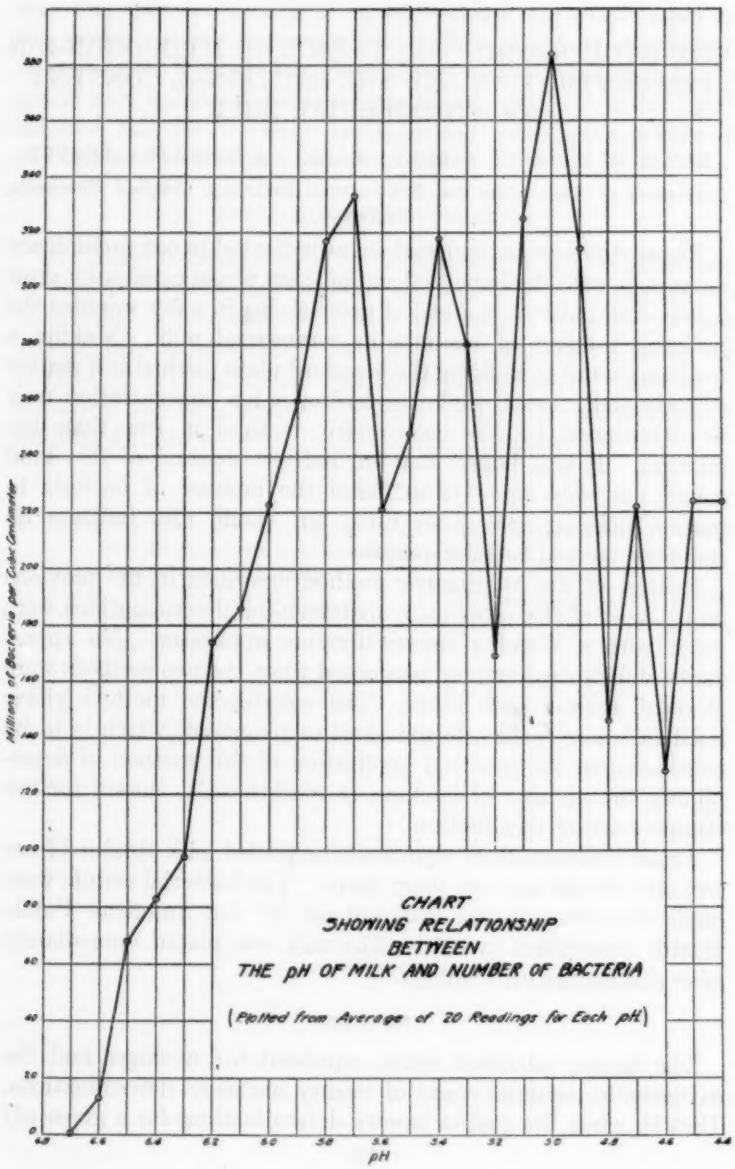
These studies were undertaken, as indicated in our preliminary report (1), with the hope that out of them would eventually grow a practical, indirect, method of ascertaining in a few minutes the probable number of bacteria in commercial milk. Making a bacterial count of milk by the standard plate method is a matter of forty-eight hours, while the hydrogen-ion concentration may be determined by the colorimetric method in less than ten minutes. It was hoped that an indirect method of this kind would not only serve to estimate the number of bacteria in market milk at any given time, but would also indicate its probable age and keeping qualities.

Instead of the colorimetric method described in the previous paper most of the subsequent hydrogen-ion determinations were made with a Wendt's electro-titration apparatus. No appreciable difference, however, was noted when the two methods were checked against each other. The colorimetric method yields itself far more readily to universal employment, which is to be considered in the practical application of this method of determining the number of bacteria in market milk, should further studies warrant its adoption.

These determinations were made on pooled milk obtained from two city dairies and one dairy farm. The bacterial counts were made according to the standard set by the American Public Health Association in 1916. The milk was plated immediately after making the pH readings.

RESULTS

The figures tabulated below represent the averages and the extremes in bacterial count of twenty unchosen determinations. That is, when the goal of twenty determinations for a given pH


Millions of Bacteria per Cubic Centimeter
pH
CHART
SHOWING RELATIONSHIP
BETWEEN
THE pH OF MILK AND NUMBER OF BACTERIA
(Plotted from Average of 20 Readings for Each pH)

was reached no further studies were made on milk at that pH, and so on until twenty determinations were made for each pH from 6.8 to 4.4.

The chart was prepared from the average counts given in the tabulation. It is, we believe, self-explanatory.

TABLE 1

Summary of results of twenty determinations for each pH

pH	HIGHEST COUNT	LOWEST COUNT	AVERAGE COUNT
6.8	110,000	750	27,500
6.7	2,500,000	15,000	395,000
6.6	68,000,000	200,000	13,000,000
6.5	325,000,000	2,500,000	68,000,000
6.4	275,000,000	5,000,000	83,000,000
6.3	300,000,000	500,000	98,000,000
6.2	2,000,000,000	2,000,000	174,000,000
6.1	700,000,000	2,000,000	186,000,000
6.0	800,000,000	15,000,000	223,000,000
5.9	1,000,000,000	10,000,000	260,000,000
5.8	600,000,000	5,000,000	317,000,000
5.7	800,000,000	16,000,000	333,000,000
5.6	500,000,000	6,000,000	221,000,000
5.5	600,000,000	7,500,000	248,000,000
5.4	700,000,000	66,000,000	318,000,000
5.3	800,000,000	4,000,000	280,000,000
5.2	500,000,000	10,000,000	169,000,000
5.1	900,000,000	5,000,000	325,000,000
5.0	1,500,000,000	6,000,000	384,000,000
4.9	800,000,000	3,000,000	314,000,000
4.8	400,000,000	2,000,000	146,000,000
4.7	600,000,000	4,000,000	222,000,000
4.6	800,000,000	2,000,000	128,000,000
4.5	500,000,000	40,000,000	224,000,000
4.4	400,000,000	64,000,000	224,000,000

DISCUSSION

Our figures show that with slight increases in hydrogen ion concentration may go enormous increases in the bacterial count. For example, fresh milk usually gave a pH reading of about 6.8 or 6.7; milk in which acidity is just detectable by taste, a reading of

about 6.0. This difference of 0.8 in the pH reading corresponds to a difference in the average bacterial counts of more than 222,000,000, or 27,000,000 for each tenth of a division in the pH scale. Furthermore, a deviation of only a tenth or two from the normal pH is associated with a bacterial count which exceeds the legal limits of most cities. Even the lowest count at 6.6 exceeds the maximum allowed in many places, certainly the average count of 13,000,000 at this pH does. At 6.5 the bacterial counts do definitely exceed the numbers generally permitted though the change in acidity cannot be detected by taste. Not only can one say that the bacterial content is exceeded but that in consequence of this the keeping quality of the milk is seriously impaired.

This brings us to an explanation of the rather marked differences between the lowest and highest count at the various pH readings. They are less disconcerting when studied together with the average counts, representing in most instances rare extremes in the count. Still, in addition to divergences which may be simply an outgrowth of technique, there must be kept in mind the fact that the flora of milk is not constant and that bacteria vary among themselves in their ferment-producing activities. Cooledge and Wyant (2) found that while the bacterial count corresponded in a general way with the keeping quality of milk, that the rate of fermentation as determined by the colorimetric method was a more accurate index.

The reason for the occilations in the average counts from 5.7 to 4.4 is not clear. It is possibly related to environmental changes —the hydrogen-ion concentration influencing the flora in one way or another. At any rate, the curve is of practical significance only from 6.6 to about 5.8, where the changes in the milk are readily enough detected.

CONCLUSIONS

The results of our studies indicate that the quality of market milk may be estimated with reasonable accuracy by measuring its hydrogen-ion concentration. Since the latter can be deter-

mined in a simple and rapid manner colorimetrically, this means of judging the quality of milk should find a large field of usefulness in the dairy industry and in the hands of consumers, especially in hospitals, etc. where it is desirable to know the quality of milk before its consumption.

REFERENCES

(1) SCHULTZ, E. W., MARX, A., AND BEAVER, H. J.: Jour. Dairy Science, 1921, iv, p. 1.
(2) COOLEDGE, L. H., AND WYANT, R. W.: Am. Jour. Pub. Health, 1920, x, p. 978.

THE PHYSICAL ANALYSIS OF DRY MILK

R. M. WASHBURN

International Dry Milk Company Laboratories, Minneapolis, Minnesota

With the increased appreciation of the place of the dairy cow as a converter of roughage and other waste into human food, and with the very great appreciation developed within the past few years of milk as a food, the attention of the scientific, the medical, the dairy, and the engineering worlds has been focused closely upon the dehydration of milk, more especially of whole milk. This was done as a means of overcoming the two great handicaps of the realization of better agriculture and better nutrition, namely, the bulkiness and the perishability of milk.

The problems in the manufacture of a standard high class, clean, and nutritious powdered skim milk have been very satisfactorily solved. The problem, however, which until recently most seriously confronted the dairy industry and the human feeding problems of the present time was the production of a powdered whole milk so made that the fat would remain sweet, non-tallowy, and non-rancid for a time sufficiently long to permit of normal marketing methods, with little loss from spoilage. For two-thirds of a century men have fought this problem with definite progress being recorded about every ten to fifteen years, until at the present time a good full-fat milk in powder form may be obtained, with sufficient effort, in most sections of the civilized world.

There are, of course, problems yet to be solved, and these, in my judgment, can be studied by what may be termed physical analysis to better advantage than by chemical analysis alone. While the latter will indicate to us the nominal food value of the product it gives us little or no idea of the structure of the powder particle, nor of the condition or position of the fatty portion within the powder, and yet upon these two things hinge, to a considerable extent, the keeping quality of all dehydrated whole

milks. The various physical aspects of the product may be briefly considered as follows:

COLOR

The color of powdered milk is but a poor guide as to its fat content for the reason that the color will vary with the feed of the cows, as with liquid milk and cream. The amount of heat applied or the cooking given also influences the color. The higher temperature or longer time produces a deeper hue, though of a brownish, rather than a yellow tint. The coarser grained powder also has a richer appearance, due to the greater absorption of the light rays in the coarser product, and its shattered reflection in the finer powder.

TEXTURE

The dehydrated milk possessing smooth, silky feel rather than the coarse, harsh condition is generally more desirable, not alone for the reason merely of the sensation produced, but due in greater measure to experience that coarse milk is usually difficult to put into solution. The finer the powder grain the more easily it will go into solution, up to about 75 microns in diameter, beyond which greater fineness is undesirable, since the particles of such powder dissolve on the outside of little lumps, and form a paste which protects the other fine particles within, and render solution less readily accomplished than would be the case with a slightly coarser grained powder, one which will allow the water to penetrate the mass. An average of about 150 microns in diameter seems most desirable.

ODOR

It is said that "the nose knows," but in the case of milk the nose may know too much. Not infrequently dehydrated milk of various types will give off an unpleasant odor when the tin is first opened, but will still reconstitute into a liquid milk wholly above criticism. Desiccated whole milk is far more likely to become tallowy than rancid or in other words, oxida-

tion rather than hydrolization takes place. But in the case of either the nose can detect its presence or its approach in advance of any but the most extremely delicate chemical test, and far ahead of the tongue.

TASTE

Powder which may reveal the first traces of oxidation of fat to the nose or which may give some of the so-called "condensed milk taste," when tasted in the powder form will not, when constituted and cooled, give any concern. Moreover, when all the people learn that the "cooked" taste is a sweet taste, made by the processes that protect them, they will look for and even seek that "sweet taste of safety."

SOLUBILITY

To meet the needs of the home trade the dehyrated whole milk should be very readily soluble in water of moderate temperature; that is, a temperature of 80 to 120°F. or not warmer than the hand could readily bear. Good powder reconstituted in such warm or semi-hot water should go into essentially complete solution in from fifteen seconds to half a minute, though the writer has repeatedly performed this task on a home scale in half of such length of time. Any milk requiring scalding temperature to dissolve the product has but limited place in the home, and would also raise the question as to whether some alkali had not been used. By solubility in this connection the writer has in mind what may be termed practical solubility; that is the dissolving of the particle to such point that no undissolved specks or flakes will appear on the glass; no portion settle to the bottom upon standing, and which will give a practically normal reading for milk in the cryoscope when reconstituted to a liquid milk having 12.50 per cent to 12.75 per cent total solids—3.5 of which are fat. Powdered whole milk is now being made, which regularly gives such satisfactory results without the addition of any alkali to facilitate solution. Any dehydrated milk which after reconstitution will, upon standing, separate showing a heavy sediment in the bottom of the glass,

and a watery zone above, is not suitably soluble even though it may have a merky, milky look when freshly stirred.

CREAM RISING

At last a system of dehydration of whole milk has been developed which will permit true cream to rise when the powder is reconstituted. Not merely a little cream or little mass of melted butter fat, but a goodly amount of true cream, practically like that on any well pastuerized liquid milk. This fete was accomplished by the development of the Dick, or Economic System, which system uses no vacuum pan, pressure spray nor drum.

It is difficult to convince the housewife that there is cream in any milk unless she can see it. Thus the struggle to develop pasteurizing machines and methods which shall render ordinary market milk safe and which will still permit the cream to rise. Moreover, unless the cream will rise on reconstituted milk it cannot be made available for use in coffee or on cereals as generally desired. The power of cream to rise or rather the power of fat to rise and drag with it portions of the milk plasma may be said to be the difference in the specific gravity between the fat and the surrounding plasma multiplied by the mass of the fat, less the retarding effect of the more or less vicid surrounding plasma. Consequently, any treatment which increases the viscosity of the plasma or sub-divides the fat into minute particles retards or prevents the cream rising by reducing the upward effect of the fat until it is less than the strength of viscosity in the plasma, retarding the fat. Such prevention of creaming is one of the reasons for the development of the homogenizer and its use in the ice cream industry. For the fat to rise as a true cream the butter fat globule must not have been melted as in the case of the vacuum pan, and to rise at all it must not have been broken up by the force of pressure spraying.

DOUBLE COLORING

It is helpful in the testing of the cream rising quality of any milk whether raw, pasteurized, or reconstituted, to add a little Soudan III solution, or other fat soluble stain. It emphasizes

the cream line. Then by adding some water-soluble stain of another color, for instance, hematoxylin, or better common green ink, the green body of the skim milk may be made to stand out in striking contrast to the orange-red of the cream; of if the cream has not risen, the location of the fat in the mass of milk is readily seen. Some milks when reconstituted show a decided sediment of undissolved milk when allowed to stand a

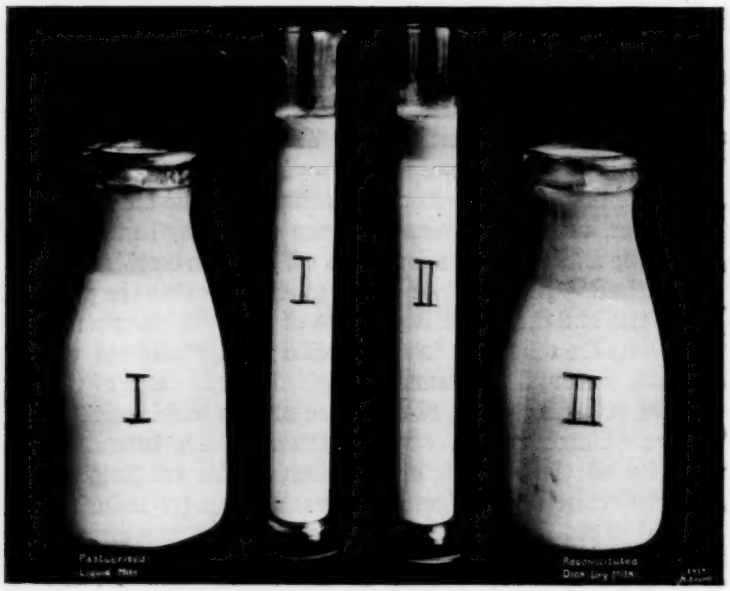


FIG. 1

few hours. Double coloring brings out these and other features. In the study of the cream rising qualities of reconstituted milk of the type most recently developed compared with normal city milk, as shown in this article, figure 1, Soudan III was used. This explains the dark color of the cream here shown. The liquid or natural milk, no. 1, is pasteurized and contains 3.45 per cent fat while no. 2 is reconstituted powdered pasteurized milk, containing 3.60 per cent fat.

CREAM SEPARATION

One test for the condition of the fat globule in any given dry milk is to reconstitute it and run same through an ordinary cream separator. If cream may be separated from the reconstituted milk, leaving only the nominal trace of fat in the skimmed milk and producing a cream which may be churned into normal butter in the ordinary way, it may be assumed that the butter fat globule has not been materially broken up by the process of manufacturing the powdered, or otherwise dehydrated milk.

DIFFERENTIAL STAINING OF POWDER GRAINS

Probably the most interesting single feature in the physical analysis of dehydrated milk is the examination of the entire, unbroken, undissolved milk grains or fragments under the microscope, especially after they have been stained, and more particularly, after the double or differential staining has been applied. "If the process employed (in the production of desiccated milk) is such as to destroy the globuler form of the fat globules, it is impossible to reduce the dried milk to a homogeneous fluid, similar to normal fresh milk" (Hunziker). And the form or condition of the fat particle can be studied by staining it a bright orange without separating it from the non-fatty constituents in which it is imbedded, and better yet, when these non-fatty elements are stained a bright blue. Thus doubly stained the condition of the fat particles and their location within the powder grains, especially with respect to their exposure to the atmosphere may be clearly studied.

The sensitiveness of most of the spray process milk powders toward oxidizing agents is augmented by the fact the atomizing process under high pressure causes a subdivision of the fat globules, depriving the fat of at least a portion of the protective gelatinous layer which surrounds each original fat globule, thereby exposing more directly to the destructive oxidizing agents.

Obviously, other things being equal, that full cream milk will keep best in which the fat globules have not been either melted

together as in the condensing pan, nor yet broken into small bids, as in the pressure spray system of dehydration. Dr. Storch showed, to his own satisfaction, many years ago that each and every fat globule was surrounded by a minute but definite gelatinous envelope, which protected the fat from oxidation, so long as it was allowed to remain unbroken. The writer has not been able as yet to stain this envelope of the fat separately from the other non-fatty elements of the powder grains, but he has succeeded in staining the fat one color, and the non-fatty portion of the powder grain another color, and this, too, without dissolving or destroying the original form of the powder grain itself. This was done by the use of the fat soluble reddish stain Soudan III followed by the water soluble blue hematoxylin, after having fixed or hardened the powder grains by brief application of ethyl alcohol 65 per cent strength. The only really difficult portion of the whole task of differential staining is in so fixing the powder that it will not be dissolved by later applications of either water or alcohol, which of necessity must form a considerable portion of stains as vehicle for the color itself. The method of staining the fat globules and their location with respect to the non-fatty portion of the milk particles, which the writer has found best adapted to his needs, and which may doubtless serve as basis for similar study by others is as follows:

1. Clean glass slides thoroughly.
2. Rub Mayer's glycerin albumin (1) evenly and not too thickly over portion of surface of slide.
3. Touch or scatter small amount of powder on the slide not too thickly so that particles do not overlap one another. Single layer deep is best.
4. Treat with ethyl alcohol 65 per cent strength one-half to one minute to harden the proteins of the powder to prevent solution later.
5. Apply Soudan III solution (2) two to five minutes, or until desired color is obtained.
6. Treat with 65 per cent ethyl alcohol one-half minute.
7. Wash gently with tap water.
8. Apply hematoxylin solution (3) three to six minutes. This stain varies greatly in strength with age.

9. Wash gently with tap water.
10. Wipe excess water from around preparation.
11. Mount in Farrant's gum mountant (4) and cover with coverglass.

The mount will keep six months to a year if stored in darkness. The blue tends to fade with time.

Reference to stains

1. Mayer's glycerin albumin mixture. Equal parts of egg albumin and glycerin thoroughly beaten and filtered. Add 1 per cent sodium salicylate to prevent decomposition.
2. Soudan III fat stain, seventy per cent ethyl alcohol supersaturated with Soudan III with the aid of heat. Let cool; then filter and it is ready for use.
3. Harris hematoxylin. Hematoxylin cryst, 1 gram; ethyl alcohol, 99 per cent, 10 cc.; dissolve hematoxylin in alcohol; alum (ammonium or potassium), 20 grams; distilled water, 200 cc. Bring mixture to a boil as rapidly as possible; then add 0.5 gram mercuric oxid and cool quickly. Filter before using.
4. Farrant's gum mountant. Picked gum arabic, 60 grams; water, 60 cc., glycerin, 30 cc.

Keep in stoppered bottle with a lump of camphor.

STUDYING THE STAINED POWDER GRAINS

A microscopic study of many of the various dehydrated milks on the market reveals the presence of essentially only three types: (1) That produced by the film or hot roller process, which gives us under the microscope a ragged looking particle with waves and wrinkles in the blue body of the milk, with reddish fat in comparatively large fragments scattered promiscuously throughout the mass, many being on the very surface, and therefore exposed to the atmosphere; (2) a powder particle made by the vacuum pan and pressure spray system which is fairly uniform in size, inclined to be sperical in form with the fat present in extremely minute particles scattered so uniformly throughout the entire mass as to cause the powder particles to assume a pink or purple color under the microscope instead of showing a field of blue containing bright orange-red spots of fat; and (3) a powder made without precondensing, and without

the pressure spray, which system produces powder grains, quite uniform in size, almost perfectly spherical in form and in which the fat globules remain unbroken, unfused, and so imbedded in the non-fatty portion, and so coated round about by a colloidal covering that it is protected thereby from the oxygen of the atmosphere.

The three types are shown in the illustrations (fig. 2), nos. 1 and 4 being the low and high magnification of the film, hot roller

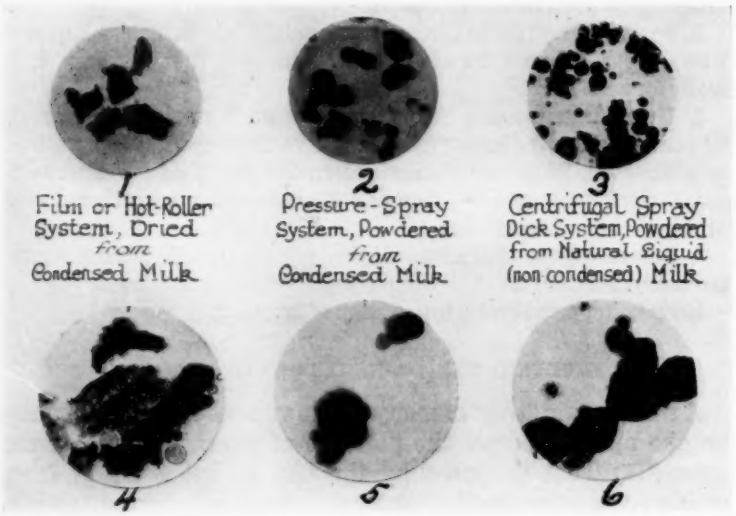


FIG. 2

or drum product. Nos. 2 and 5 are of the pressure sprayed product from condensed milk, and nos. 3 and 6 illustrate the physical makeup of the powder resulting from the Dick process of dehydration. The presence of essentially unbroken globules of fat is indicated by the irregular dark areas (orange-red photographs black) within the powder grain while the blue colloid which surrounds the fat and protects it is shown in the photograph as a light zone (blue takes light). When examining the prepared slide under the micro-

scope by focusing on the smaller powder grains at the point of greatest diameter the enveloping or incysting colloid will be seen as a blue line. The fact that the membrane surrounding the fat has remained unbroken and that the globules are imbedded within the powder grain, surrounded by what is essentially a dry capsule undoubtedly accounts in considerable measure for the unusual keeping quality of powder of this type.

Screwing the microscope down until it crushes a few powder grains, and releases the fat globules, is of passing interest in the study of the physical makeup of powder grains.

The microscope also reveals in the differentially stained powder grain occasional droplets of water, and not infrequently particles of air also within the grain. These are indicated by their refraction.

COLORED LIGHTS

Another interesting phase of this study is the examination of these products unstained but by the aid of lights of different color. Characters which are not discernable with white light become readily seen by means of orange, red or green lights of various intensities. Light intensifiers, as well as the desired colors, may be made by the use of a globuler shaped 500-cc. flask filled with water colored with water soluble analine dyes, potassium bichromate, sodium hydroxide and phenolphthalein, or even red and green ink using a common white electric light back of the flask.

SOME PHYSICAL ASPECTS OF DIGESTION

Although milk is generally ingested a liquid, it remains so normally only eight to twelve minutes, by which time the pepsin-rennet ferments, acting in coöperation with the acids of both the milk and the stomach, bring about a curdling. This curd mass begins almost at once to contract and squeeze out the whey, which, carrying most of the sugar and albumen, trickles on into the small intestine where digeston takes place. The mass of curd made up of a mesh of casein filiments, retaining the fat mechanically, remains in the stomach for a considerable

time, three hours or longer, being gradually broken up into small bits and doled out slowly for further digestive action. The retardation seems to form a real step in the best handling of the food.

Reconstituted milks in general respond to this curd formation nearly if not quite as quickly as natural liquid milk, but produce a slightly more tender, even flocculent first curd. After the whey portion has been forced out the remaining curd, if of raw milk, is firm, close in texture and almost rubbery, but if from reconstituted milk is mellow, tender and friable. Curds from reconstituted milks therefore are far more nearly like those goat's and breast milk. They require little or no barley or oatmeal water to cause friability as in the case of natural liquid cows' milk when fed to infants.

The breaking up of the fat globules, in some of the processes, does no harm to the feeding value nor does such improve it. (Confer pages 56, 57, 68, 69, 103, 104, and illustrations opposite pages 32 and 64, Bulletin 195, Vermont Experimental Station, 1916.) From the physical standpoint reconstituted milk is superior to natural raw milk for infant and child feeding.

Fascinating and productive studies may be carried on to the advantage of the dairy industry and all concerned by differential coloring and staining of liquid and dry milk, and by yet closer study into other physical properties and conditions of milk and its products.

A METHOD FOR THE DETERMINATION OF AMINO NITROGEN AND AMMONIA IN CREAM AND BUTTER[1]

L. W. FERRIS

Food Control Laboratory, Bureau of Chemistry, United States Department of Agriculture

It is the general opinion of dairy chemists that the nitrogenous constituents of milk and cream undergo certain changes which begin at an early stage, the degree of change depending, principally, upon the kind and amount of contamination and the temperature at which the product is held. These changes may be caused by the action of enzymes and bacteria upon the proteins with the production of intermediary products of more or less complexity, the simplest being the amino acids. The more favorable the conditions for enzymic and bacterial activity, the greater should be the number of amino groups formed from the original protein. A determination of the amino nitrogen reacting with nitrous acid in a solution from which the undecomposed proteins have been removed by filtration, will be a measure of the proteolysis that has taken place except for the nitrogen that has been synthesized into protein by the microorganisms present. In studying the decomposition of cream and butter, this method is used to show the relation of amino nitrogen to the quality of the product. In the manufacture of butter, some of the nitrogenous constituents of the cream are occluded by the fat and remain in the finished product. In order to measure the relative proportion of amino nitrogen in milk, cream, buttermilk and butter, it is desirable to have a procedure that is adaptable to all of these products. Acetic acid, as used to precipitate the casein in milk will not always work satisfactorily on cream and butter, especially when considerable proteolysis has taken place. In some cases the precipitation of the casein is incomplete and filtration extremely slow and difficult. In the procedure outlined below, picric acid and acetic together have been used satisfactorily to

[1] Published by the permission of the Secretary of Agriculture.

separate the protein and higher complex substances from the lower degradation products in milk, cream, buttermilk and butter. Picric acid not only acts as a protein precipitant, but also as a preservative, so that the filtrate can be held for some time without any appreciable change taking place in the amount of nitrogen reacting with nitrous acid. This makes it possible to prepare samples of cream or butter at any creamery so that the analysis can be made later at a fully equipped laboratory.

The determination was made as follows: A 15-gram sample of cream was weighed in a flask of about 100 cc. capacity, 5 cc. of 10 per cent acetic acid and 30 cc. of a saturated solution of picric acid added, and the mixture shaken for half an hour or at intervals for two hours. The solution was filtered on a dry filter and 10 cc. of the filtrate taken for determination of reacting amino nitrogen in Van Slyke's apparatus, using the large reacting bulb and the 10 cc. gas burette. The weight of sample represented by the 10 cc. aliquot of the filtrate, is determined by taking, as the entire volume of solution, the calculated water in the sample of cream and in the added reagents. All results were figured to per cent of the total nitrogen in the sample. For the determination of amino nitrogen in butter, a 100-gram sample was weighed in a 250 cc. ground glass stoppered bottle while the sample was of such a consistency that it could be poured and yet not have any separation of the fat and curd. The bottle was then filled to the shoulder with petroleum ether, boiling point above 55°C., which had been warmed a few degrees above room temperature. The fat was dissolved by shaking the tightly stoppered bottle vigorously for a few seconds and the separation completed by centrifuging and syphoning off the solution, leaving the curd in a compact mass at the bottom. To this residue were added 5 cc. of 10 per cent acetic acid and 30 cc. of a saturated solution of picric acid, the mixture shaken, filtered, and amino nitrogen determined as on the filtrate from cream.

In order to show how completely amino acids could be determined by this procedure, a sample of pure glutamic acid and a portion of the products formed by the acid hydrolysis of casein were added to a sample of butter. The reacting amino nitrogen

was determined as above and the results, as given in table 1, showed that practically all the added amino nitrogen was recovered.

In table 2 are given the results by the above procedure on two kinds of cream. A number of samples were prepared from each cream and the amino nitrogen determined in the filtrates when freshly prepared and after standing the number of days indicated in column 1. Cream no. 1 was a sample of raw cream which had been kept in the ice box forty-nine days, and no. 2 was a sample of fresh sweet cream. The results, as given in columns 2 and 4, show that there was no change in the amount of reacting nitrogen when the filtrate was kept at room temperature for two

TABLE 1

Showing recovery of known amounts of amino acids in filtrate from picric acid and acetic acid precipitation of curd of butter

NUMBER	AMINO ACID ADDED	AMINO NITROGEN		RECOVERY
		Added	Found	
		per cent	*per cent*	*per cent*
1	None	None	0.0009	
2	Acid hydrolysis products	0.0751	0.0737	96.9
3	Acid hydrolysis products	0.0738	0.0752	100.7
4	Acid hydrolysis products	0.0369	0.0369	97.6
5	None	None	0.0003	
6	Glutamic acid	0.0188	0.0191	100.0

weeks. To another set of samples acetic acid and picric acid were added and the mixture shaken and kept at room temperature, the time being shown in column 1. These samples were filtered immediately before the determination of amino nitrogen was made. The results, as given in columns 3 and 5, show that there was a slight, though noticeable, increase, in the amount of amino nitrogen.

Table 3 shows the contrast that may be obtained by this procedure on sweet cream and on decomposed cream. In the sweet cream, the amino nitrogen was approximately 2 per cent of the total nitrogen. This figure was increased to 5.8 per cent when the cream was kept at room temperature for six days, and to 19.4 per cent of the total nitrogen after twelve days. Since a sample

TABLE 2

Amino nitrogen as per cent of total nitrogen

DAYS HELD	OLD CREAM		SWEET CREAM	
	Filtered at once	Held without filtering	Filtered at once	Held without filtering
0	6.84 6.76	6.84 6.76	1.81 1.61	1.81 1.61
1	6.58 7.14		2.00 2.15	
2	7.08 7.08	7.11 7.38	1.60 1.59	
3				1.94 1.94
4	6.58 6.76	7.06 7.00	2.08 2.04	
5				2.24 2.22
7			2.07	
8				2.48 2.26
9	6.92	7.62 7.62	1.86 1.90	2.66 2.36
10				2.67 2.67
15		7.56 7.77	1.96	
16	6.74			3.20 3.05

of cream from the same source as the above showed only 6.8 per cent amino nitrogen, after being held in the ice box for forty-nine days, it is evident that temperature has a very great influence in the formation of free amino groups from the protein complexes. A similar contrast is shown on some samples of experimental

TABLE 3

Showing amino nitrogen as per cent of total nitrogen in cream samples

NUMBER	DESCRIPTION OF SAMPLES	AMINO NITROGEN AS PER CENT OF TOTAL NITROGEN
1	Sweet cream	1.7
2	Sweet cream	1.7
3	Sweet cream	2.2
4	Raw cream held six days at room temperature	5.8
5	Above sample held twelve days at room temperature.	19.4
6	Raw cream held in ice box forty-nine days	6.8
7	Raw cream held in ice box forty-eight days	7.4

butters as shown by the results reported in table 4, the per cent of amino nitrogen in the last sample being approximately 13 times that of sample no. 1, which was a fresh butter from sweet cream.

TABLE 4

Showing amino nitrogen as per cent of total nitrogen in samples of butter varying in quality

NUMBER	DESCRIPTION OF SAMPLE	AMINO NITROGEN IN PER CENT OF TOTAL NITROGEN
1	Fresh butter from sweet cream	1.4
2	Fresh butter from neutralized sour cream	3.3
3	Experimental butter from neutralized sour cream, held in cold storage six months, then at room temperature one week	6.5
4	Above sample no. 3, after standing at room temperature one month and twenty days	18.1

In order to show the effect upon the amounts of amino nitrogen found by different procedures, a comparison of the above picric acid method was made with the following: In table 5, with a solution of the curd of butter in 50 per cent acetic acid; in table 6, with an aqueous suspension of the curd of butter concentrated on the stream bath; and in table 7, with a suspension of the curd in

TABLE 5

Showing amino nitrogen as per cent of total nitrogen in (A) picric acid and acetic filtrate; and (B) in curd of butter dissolved in 50 per cent acetic acid by heating for one hour at 50°C.

NUMBER	DESCRIPTION OF SAMPLE	AMINO NITROGEN AS PER CENT OF TOTAL NITROGEN		
		A	B	Difference
1	Sweet cream butter	1.3	10.4	9.1
2	Sweet cream butter	2.0	10.5	8.5
3	Sour cream butter	3.3	13.0	9.7
4	Sour cream butter	3.8	14.9	11.1
5	Neutralized sour cream butter	3.8	29.0	25.2
6	Neutralized sour cream butter	4.1	19.1	15.0
7	Neutralized sour cream butter	5.2	15.0	9.8
8	Neutralized sour cream butter no. 3, table 2	6.5	17.2	10.7
9	Sour cream butter	7.7	21.9	14.2
10	Old rancid butter	9.0	65.2	56.2

TABLE 6

Showing amino nitrogen as per cent of total nitrogen in butter: (A), picric acid and acetic acid filtrate; and (B), in suspension of curd washed from butter fat with hot water and concentrated on steam bath

NUMBER	DESCRIPTION OF SAMPLE	PER CENT OF TOTAL NITROGEN AS AMINO ACID		
		A	B	Difference
1	Sweet cream butter	1.6	11.5	9.9
2	Neutralized sour cream butter (no. 6, table 3)	4.1	18.2	14.1
3	Sour cream butter no. 9, table 3	7.7	28.7	21.0
4	Neutralized sour cream butter	9.5	28.0	18.5
5	Rancid butter no. 10, table 3	9.0	45.4	36.4

TABLE 7

Showing amino nitrogen as per cent of total nitrogen of butter in: (A) picric acid and acetic acid filtrate; and (B) suspension of curd in water after distilling off ammonia under reduced pressure

SAMPLE NUMBER	DESCRIPTION OF SAMPLE	ALKALI USED IN DISTILLATION	PER CENT OF TOTAL NITROGE AS AMINO NITROGEN		
			A	B	Difference
1	No. 3, table 3	Na_2CO_3	3.3	20.3	17.0
2	No. 3, table 2	MgO	6.5	33.0	26.5
3	Neutralized sour cream butter	$MgCO_3$	4.0	16.4	12.4

water after the ammonia had been removed by vacuum distillation. In every case the picric acid procedure gave lower results although there was a greater difference between samples of different quality by the picric acid method than by allowing nitrous acid to react on a suspension of the entire curd of the butter. There is a greater increase of amino nitrogen by the latter procedure on old butter than on fresh butter, which indicates that the protein of old butter is more readily hydrolyzed than that of fresh sweet cream butter. Therefore, when the amount of amino nitrogen present in a sample of cream or butter is used as an index of the quality of the sample, the determination in the acetic acid and picric acid filtrate will more nearly represent the amount actually present.

The advantages of the use of picric acid and acetic acid in preparing samples of milk, cream, buttermilk and butter for determination of the nitrogen reacting with nitrous acid in Van Slyke's apparatus as an index of proteolysis are:

1. Easy and rapid separation of the proteins and more complex substances from the lower degradation products, principally amino acids.
2. Hydrolysis of proteins during analysis is reduced to a minimum.
3. The filtrate can be held without further change, allowing a reasonable time between preparation of sample and analysis.
4. A correlation between amount of amino nitrogen and quality of sample.

By this procedure the amino nitrogen and ammonia in 14 samples of fresh butter from sweet cream was found to range from 0.9 to 2.3, with an average of 1.4 expressed as per cent of the total nitrogen.

THE DANGER OF IMPROPERLY CAPPED MILK BOTTLES[1]

J. G. JACKLEY

Division of Animal Industry State Department of Agriculture, Sacramento, California

INTRODUCTION

Except in the case of our certified milks, the protection that the dairyman and distributor can give the milk ceases when it is bottled and left by the driver on the consumer's doorstep; in fact, it can be said that the protection essentially ceases at the time when the milk is bottled. During the interval between the bottling and consumption of the milk there exists a period when the "safety bars" are let down, so to speak. I refer to the imperfect covering for the top of the milk bottle—the so-called slip-in type of bottle cap which leaves the lip of the bottle and the top entirely exposed. The writer has frequently noticed a bottle of milk on the family doorstep surrounded by flies and often a dog or cat licking the droplets of milk from the top. Aside from the repulsiveness of such occurrences, the rôle of flies in the transmission of typhoid and numerous other diseases is so well estabtablished that a discussion is unnecessary.

But probably most important, although least thought of, is the fact that the bottle is grasped around the top by the driver or other person handling it. The objection to this practice is obvious. Sanitarians have long insisted upon the danger of unclean hands of employees handling food stuffs, and in the case of a product so delicate and perishable as milk, this danger and objection is doubly serious.

The certified dairies have solved the uncovered bottle top problem by supplying a cover that slips over the outside, thus protecting the lip of the bottle over which the milk must pass

[1] Paper read at the annual meeting of the California Association of Dairy and Milk Inspectors, Santa Monica, California, September 28, 1921.

when being poured out. These covers are recognized as being ideal and very desirable, but as yet only a small portion of our milk is so delivered due to the considerable additional expense. The slip-in type of bottle cap is far more common due to the ease and simplicity of use and low cost. Probably 90 per cent of all bottled milk is served to the patron in this latter type of bottle and cap.

EXPERIMENTAL WORK

In order to ascertain the extent of contamination possible to the contents of the milk bottle when the lip of the bottle was artificially infected, the following work was carried out.

Protocol 1

Six half-pint bottles of milk, covered by inverting glass tumblers over the tops, were sterilized in the autoclave at twenty pounds steam pressure for thirty minutes.

The lip of each of three bottles was then infected by transferring a loop of a broth culture of streptococcus to the outer margin.

The infected spot on each bottle was wiped with a piece of sterile dampened gauze and 3 cc. of the milk poured from each bottle to a sterile test tube.

The three remaining uninfected bottles were each wiped with sterile dampened gauze and 3 cc. of the milk poured into sterile tubes (controls).

Results: After four days the test tubes of milk from infected bottles were solidly coagulated and showed the presence of streptococci. The test tubes of milk from the controls remained sterile.

Protocol 2

Same technique as outlined for protocol 1 except that B. subtilus (six days old sporulating) culture was substituted.

Results: Infected bottles all showed peptonization of the milk after seven days. Controls remained sterile.

The common custom of wiping the lip of the milk bottle with a damp dishcloth before taking out the cap suggested the use of the sterile gauze in protocols 1 and 2. The housewife generally believes that wiping with a dishcloth cleans the bottle. That the idea is a fallacy is shown by the fact that even the sterile gauze

failed to clean the neck from infection. The fact that the dishcloth will remove visible dirt no doubt accounts for the reliance generally given this much-used implement of the household. To prove that "visible-cleanness" does not necessarily run parallel with "bacteriological-cleanness" is demonstrated in the next experiment.

Protocol 3

Three sterile bottles were wiped with a dishcloth secured from an average household and impressions made of each by inverting sterile agar plates over the top of the bottles.

Results: All three plates gave heavy growths (fig. 1).

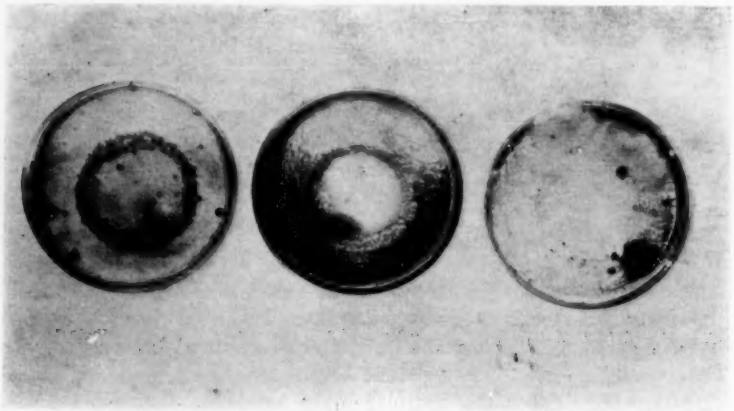


FIG. 1. BOTTLE TOPS WIPED WITH A DISHCLOTH; IMPRESSIONS MADE ON STERILE AGAR PLATES

A second set of exposures was necessary to get good pictures; consequently, some air-contaminating organisms are shown over the surface of the plates.

QUALITATIVE STUDY

It would be natural to assume that the bacterial flora adhering to the lip of an ordinary milk bottle might vary greatly. For the purpose of this work, however, identification of all species seemed unnecessary and consequently only the colon-typhoid group was investigated.

Protocol 4

Several bottles of milk were purchased on the market from different dairies and impressions made of each on petri dishes by resting an inverted plate of Endo agar on the top of the bottle.

Results: The average colon count for eight plates gave 21 (fig. 2).

No attempt was made in this examination to differentiate the members of the colon group.

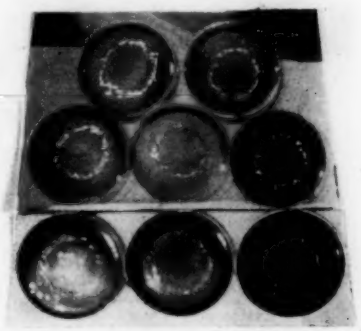


FIG. 2. ENDO AGAR COLON-AEROGENES GROUP

The small snapshots of the petri dishes did not bring out the growths satisfactorily, hence the prints have been retouched with white ink.

PROTECTIVE MEASURES

The work thus far shows that serious contamination from the lip of the bottle is a possibility. It occurred to the writer that some means of eliminating or controlling this condition would be valuable information. Aside from the use of the bottle-top-cover-cap (used chiefly by our certified dairies) which seems prohibitive for the general milk trade due to the expense, several methods came to mind:

Washing the neck of the bottle with hot water and soap would not be highly efficient at best and probably would be of little value, if done at all. Washing the lip of the bottle with a disin-

fectant could not be safely recommended for general use. "Burning off" the lip of the bottle over the free flame of a gas stove appeared practical and feasible.

Protocol 5

Three sterile bottles were infected with a broth culture of B. subtilus. Each was wiped with sterile gauze. The lip of bottle 1 was *not* subjected to "burning off." Bottle 2 was "burned off" by turning the bottle one complete revolution through the flame followed by rolling the lip of the bottle on the surface of a plate of solidified sterile agar. Bottle 3 was "burned off" by turning six times and rolling on the surface of an agar plate as above.

Results: Bottles 1 and 2 showed heavy growths; no. 3 showed none.

The results of the preceding experiment show that one complete turn of the bottle thru the flame did not materially reduce the infection of the lip of the bottle and that six complete turns did apparently render the lip sterile. In order to determine the least amount of burning necessary, impressions of the lips of a series of bottles of market milk were made on sterile agar plates; the lip of each bottle was then wiped with a damp dishcloth and another impression made on a sterile plate; finally the lip of each bottle was burned off by passing through the free flame of a gas stove while making one, two or three complete revolutions of the bottle and again making impressions on agar plates.

RESULTS

Most of the bottles gave less growths before being wiped, showing conclusively that the dishcloth either spreads the contamination or adds more to the bottle. Nevertheless, proper "burning off" even after wiping reduced the resultant growth to zero or a very negligible amount. Three turns of the bottles through the flame appeared sufficient in most cases.

CONCLUSIONS

1. Serious contamination from the lip of the milk bottle is possible.

2. A cap that covers the lip or rim of the bottle is undoubtedly the ideal protection.

3. In the absence of a cover-cap a practical protective measure is offered for use especially during outbreaks of communicable diseases.

RECOMMENDATIONS

1. "Burning off" the lip of the bottle by turning the bottle rapidly over the free flame of an ordinary gas cook stove will practically render the same sterile if done properly.

2. "Burning off" the lip of the bottle is practical, simple, inexpensive, and safe for any one to do.

3. The turning must be done quickly else the bottle may be cracked. The rule followed in this work has been to count 5 to 8 rapidly turning the bottle while counting. The lip only (not the entire neck) of bottle should be held in the flame.

4. By burning off the lip of the bottle as soon as the milk is brought into the house the cream will have ample opportunity to again set before the milk is to be used.

THE MILKING MACHINE AN IMPORTANT FACTOR IN MILK QUALITY

JAMES D. BREW

Dairy Extension Department, Cornell University, Ithaca, New York

For a good many years most of the fluid milk producers in New York State have had to produce milk in accordance with health board regulations which limit the number of bacteria in the milk at the time of delivery. Back of this is the assumption that milk, produced and handled so that its germ content is uniformly low, will be on the whole safer and better in quality than milk normally high in germ content. There is room for differences of opinion regarding certain exceptions to this statement, but, so far as the general milk supply is concerned, it unquestionably is true.

The outstanding requirement in practically all of these regulations is, that all milk must be classed into grades. In the grades, usually designated as A, B, or C, are specified more or less arbitrary standards governing the conditions under which the milk is to be produced and the number of bacteria allowed for each grade. The latter requirement is the important one because of its true relation to actual quality, and constitutes one of the big problems confronting the producers of fluid milk, particularly. The force of this statement is appreciated when one considers the bacterial requirements for each grade as established, for instance by the New York City Board of Health. Milk, to qualify as grade A, raw, "shall not contain more than thirty thousand (30,000) bacteria (colonies) per cubic centimeter when delivered to the consumer or at any time prior to such delivery." Milk to qualify for pasteurization as grade A in the country but to be sold in the city "shall not contain more than one hundred thousand (100,000) bacteria (colonies) per cubic centimeter at any time before pasteurization." The limit for milk to be pasteurized as grade B is 300,000 per cubic centimeter. In order to insure the low counts specified in grade A, many

commercial fluid milk dealers offer to the patrons a certain premium per hundred weight for milk delivered to their plant with a count under 10,000 per cubic centimeter (agar plate counts). A smaller premium is paid if the count is between 10,000 and 25,000 per cubic centimeter. These premiums are sufficiently great to be well worth striving for; consequently, the influence of any dairy operation upon the germ content is of economic importance to the dairymen.

No small amount of difficulty is encountered by the dairymen in meeting these bacteriological requirements. During March, 1921, the Dairy Department of the New York State College of Agriculture instituted an educational program of extension work designed to bring directly to the producers of milk, information concerning the sources of bacteria in milk and their relationship to quality. The method of procedure will not be given here since it has already been discussed in detail in the JOURNAL. The work is based upon a bacteriological study, by means of the direct microscopic method of the milk as delivered by the patrons at any given piant on two or three successive days. The results are presented and discussed at a previously advertised meeting of the patrons. The grading of the milk in this way makes it possible to collect valuable information regarding the general quality of the milk as delivered by the dairymen and the most important factors affecting the bacteria content. From March until September, inclusive, the quality of milk at fifteen fluid milk plants has been studied in this way.

High bacteria counts in milk are due to excessive contamination, primarily from the things with which the milk comes in contact, or to improper cooling, or to both combined. In studying milk under the microscope it is possible to note the general types of bacteria present and to roughly classify them according to their probable source. For instance, a predominance of lactic-acid-producing types in the milk as delivered by a patron, indicates lack of cooling. A predominance of organisms which form large clumps indicates utensil contamination. Long-chained streptococci associated with leucocytes serve as a basis for suspecting some form of infections garget. Recent observa-

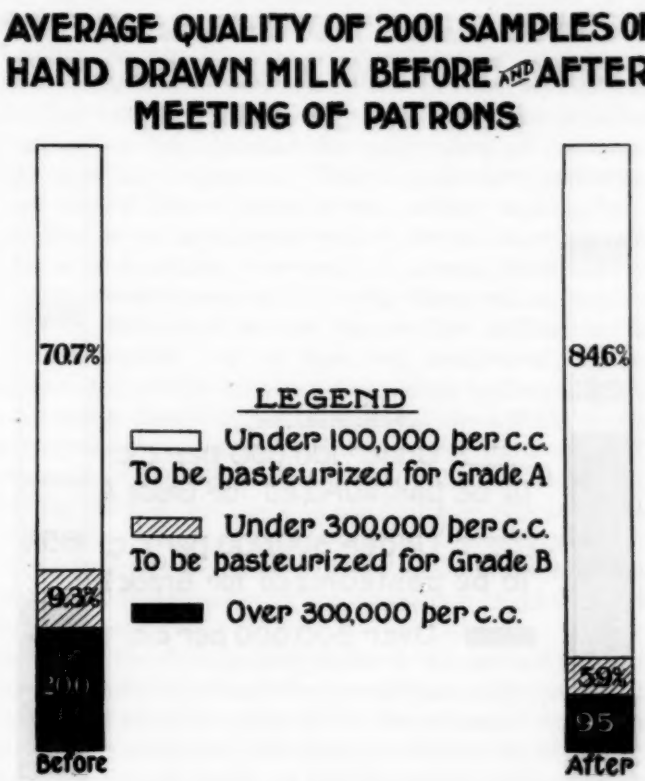
tions on milk machine contamination have revealed the fact that the predominant flora of machine-drawn milk frequently consists of a mixture of the large clump-forming micrococci and the long-chained streptococci, which are, at least morphologically, identical with the forms commonly associated with garget. By tracing back individual cases to the farm, it has been proved beyond doubt that improperly cleaned milking machines may harbor the long-chained forms in sufficient numbers to yield an initial contamination to a full can of milk of over 1,000,000 groups per cubic centimeter. It would not do to assume that these long-chained forms are the causative agents of infectious garget. The resemblance may be purely morphological, but their presence serves as a guide to the source of contamination, and until more is known as to their exact identity they should be regarded as a possible source of an outbreak of garget in the herd. In several instances a thorough cleaning of the machine eliminated them, together with micrococci forms, to the extent that none could be found after searching as many as one hundred fields of the microscope. This classification of types as regards their possible origin is not absolute by any means, but is sufficiently so, to be of great assistance in locating the cause of high counts.

Thus far the observations made in grading 3243 samples from milk delivered by 1104 patrons have led to the conclusion that the commonest causes of high bacteria counts in milk at the time of delivery to the plant are: (1) failure to promptly and properly cool; (2) high contamination of milk by cans and other utensils which have not been thoroughly steamed or scalded, or promptly dried, and (3) high contaminations from dirty milking machines. There is little question that if these three factors were properly controlled the amount of milk high in bacteria count, due to other possible sources of contamination, would be insignificant in comparison to the total quantity delivered.

The data collected in these studies have made it possible to accumulate fairly accurate information concerning the bacterial quality of machine-drawn milk as compared to hand-drawn milk. The observations on the bacterial quality of milk as affected by milking machines were made at twelve of the fifteen plants,

comprising 790 patrons, of which 635 were hand milkers and 155 were users of milking machines.

Wherever possible, it is highly important that the milk at each plant be again graded after the meeting of the patrons as well as

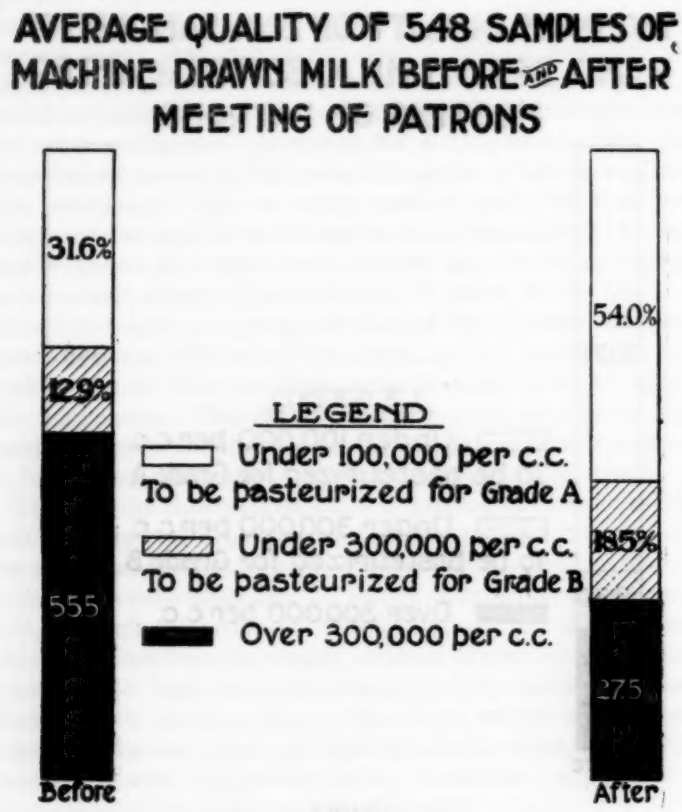


GRAPH 1

before, in order to determine the extent of improvement made as a result of putting into effect some of the recommendations made. In graph 1 is shown the percentage rating of 2001 samples of hand-drawn milk before and after the meetings of the patrons.

In graph 2 is shown the percentage rating of 548 samples of machine-drawn milk before and after the meetings of the patrons.

The picture presented in these graphs clearly indicates that the milking machine contributes a large share toward high bac-



GRAPH 2

teria counts. There is good reason to believe that the cooling and other dairy operations are done equally well by both classes of milkers; but the difference between the amounts of milk

delivered by each that contained more than 300,000 bacteria per cubic centimeter is so great as to leave no doubt that the milking machine, as it is cleaned and cared for on the average farm, is a serious source of contamination. In fact, approximately three times as much inferior milk was delivered by users of machines as by hand milkers.

Considerable opposition has developed in dairy sanitary circles against the use of milk machines because so much milk inferior in quality has been delivered by the users. In too many instances this opposition has assumed the proportions of a predjudice against their use in general. This is particularly unfortunate, because due to labor conditions, the milking machine has undoubtedly become an essential part of modern dairy equipment. Instead of its decreasing in general use, as some think will be the case, there is every reason to believe that there will be an increase.

There is little question that the modern milking machine, from a mechanical point of view, will satisfactorily draw the milk from the cow if it is operated according to directions. Also the statement cannot be questioned that the milking machine, if properly operated, eliminates to a very large degree much of the unpleasantness so characteristic of hand milking. Furthermore, because of the fact that one man can normally milk from twenty to twenty-five cows per hour, requiring less average time per cow than is required in hand milking, the milking machine is an important economic factor in the production of milk, especially with large herds.

At present the chief limiting factor in the successful operation of milking machines is the lack of recognition on the part of many dairymen and machine agents of the importance of proper cleaning. If measures are not taken fairly promptly, by all concerned, to make the general quality of machine-drawn milk equal to that drawn by hand, there is danger of a reaction against a very useful and practical method for milking cows.

Not infrequently the question is raised as to whether it is possible to produce a high-grade milk where machines are used. Abundant evidence exists to answer this affirmatively. Producers of certified milk are successful in meeting the bacterial

requirements, as are also many dairymen who sell milk where premiums are paid if the bacteria count averages under 10,000 per cubic centimeter. At the Clover Farms Dairy Company's Plant at Homer, New York, where milk has been bought on this basis for a number of years, 54 per cent of the twenty-six users of machines during April, May and June, 1921, produced milk with a count under the 10,000 per cubic centimeter according to the counts made by the Company, and 23.7 per cent produced milk with a count between 10,000 and 25,000 per cubic centimeter. Only 6.6 per cent produced milk containing over 300,000 bacteria per cubic centimeter. The hand milkers, however, did somewhat better, 74.7 per cent being under the 10,000, 12.1 per cent between 10,000 and 25,000 and only 3.5 per cent producing milk with more than 300,000 bacteria per cubic centimeter. While the advantage appears to be in favor of the hand milkers, yet in the case of the users of milking machines the 54 per cent constitutes sufficient evidence to indicate what can be done if strict attention is given to all details. As shown by the results pictured in graph 2, substantiated by observations in the field, the production of milk at least good enough in quality to qualify for pasteurization as grade A is a comparatively simple matter if attention is paid to a few essentials. Refering to graph 2, the 55.5 per cent over 300,000 before the meeting of the patrons and the 27.5 per cent after the meeting are the result of gross carelessness or misinformation. Much of this, of course, may be traced to the dairyman's lack of information regarding bacteriological relationships, and until some appreciation of the importance of the common sources of bacterial contamination is acquired, the users of milking machines will continue to lag considerably behind the hand milkers so far as bacteria counts of milk are concerned.

The milking machine, with its more or less complicated mechanism—pulsators, heavy pail and lid, valves, rubber rings, moisture traps, rubber tubing, inflations, test cups; and so on, with most of which the milk comes directly in contact—constitutes a fertile source of contamination unless special precautions are observed. Among the first considerations before installing any machine

should be the question as to whether or not the dairyman is equipped to keep it properly cleaned at all times.

No small share of the responsibility for the dispensation of misinformation regarding what is involved in keeping machines properly cleaned, rests upon the local machine agents. In fact it has been common for them to minimize the importance of cleanliness for fear of jeopardizing the prospect of a sale. Many a dairyman has been told that all that need be done is to simply rinse the machine and the rubber parts out each time it is used with a little cold water and then keep the rubber parts in a disinfecting solution which will render them sterile. Or dairymen are frequently told to merely immerse the rubber parts in cold water, without specifying the degree of coldness or cleanliness. Not having been given any specific information or precautions, it invariably happens within a short time that such dairymen are immersing the rubber parts in foul-smelling solutions, rich in bacterial growth.

Another factor which plays a prominent part in the production of so much machine-drawn milk inferior in quality is the fact that so many dairymen have not provided themselves with the proper facilities for cleaning. This includes, in particular a sufficient supply of boiling water.

Just what is the best procedure to insure the production of a high quality of machine-drawn milk is a much-debated question. A good many authorities maintain that this can be accomplished only by deciding on one particular method for cleaning and then by means of dairy inspection, enforcing this method. Anyone experienced in the field will see that such a procedure is impracticable, largely because dairy operations of any kind are subject to change at least twice daily and also because human nature, which is uncontrollable, is prone to take "short cuts." The temptation is strong, and even natural, to evade all requirements, particularly those based on the enforcement of methods. An enforcement to insure results, would require a force of dairy inspectors involving an expense that would be prohibitive. It would also have the added objection that many users producing a high quality of milk would be required to change to one method

for the sake of uniformity. This would in many cases prove uneconomical, because frequently a dairyman is so situated that he can use some other method or modification to a better advantage, and at the same time not sacrifice high quality. The question from a scientific and practical point of view is what results are being obtained, and not what method is being used.

At a milker conference held in Geneva, May 27, 1921, which was attended by representatives of most of the milking machine companies, the general question of the influence of machines upon quality was thoroughly discussed. The most encouraging feature of this conference was the clearly evidenced appreciation of the situation by these representatives. This has manifested itself in a voluntary coöperation to devise ways and means for putting the sales end of their business on a basis which promises to insure a better quality of machine-drawn milk. It will require time to work out such a program, but the plan deserves the support of all interested in milk production and control.

"Buflovak" Process

For Manufacturing

Powdered Milk Products

THE "Buflovak" Process of producing powdered milk is gradually replacing other methods because of certain inherent advantages which are lacking in most every other system. Some of these advantages are as follows:

Solubility—Dry milk solubility is often destroyed by overheating, which cannot occur in the "Buflovak" Process because of the high vacuum and consequent low temperature.

Flavor—The decidedly brief exposure of the milk to the heating surface preserves the natural flavor to a far greater extent than is possible where the milk is heated for long periods

Uniformity—Our patented devices (not obtainable in any other process) insures a uniform degree of dryness, which is not affected by changes in humidity or other atmospheric conditions.

High Yield—No solids can escape with the vapor. Consequently you receive the highest possible yield from each gallon of milk.

Cleanliness—The evaporating and drying equipment are so constructed that all parts of the interior are easily reached and can be thoroughly cleaned.

Low Cost of Production—The cost of production is surprisingly low—in fact much lower than with any other known system, and enables the manufacturer to produce dry milk at a good profit even when milk prices are at a low level.

"Buflovak" apparatus is sold outright under a substantial guarantee; consequently there are no royalties to be paid, a considerable saving in itself.

Send for the dry milk booklet.

Buffalo Foundry & Machine Co.

1581 Fillmore Ave., Buffalo, N. Y.

NEW YORK OFFICE: 17 BATTERY PLACE

DRAWINGS, ARTISTS' WORK AND ENGRAVINGS FOR MEDICAL AND SCIENTIFIC PUBLICATIONS

PUBLISHERS and authors working in the scientific field will be interested in our facilities for producing illustrations for such work. We have had years of experience in working in co-operation with some of the prominent authors and scientists of the Johns Hopkins University, which has developed in our organization an intimate knowledge of the requirements of this particular line of work. We offer you the services of the specialist in this line. Such are not available in every community, and as we are accustomed to working from written instructions, our clientele being largely at distant points, we subconsciously understand the illustrative point to emphasize, and have been very successful in satisfying our most critical patrons.

We will gladly make estimates, submit samples, and co-operate in every way possible in the production of such work.

BALTIMORE MARYLAND
ENGRAVING COMPANY

BALTIMORE, MARYLAND

"SCIENTIA"

INTERNATIONAL REVIEW OF SCIENTIFIC SYNTHESIS
Issued Monthly (each number consisting of 100 to 120 pages.)
Editor: **EUGENIO RIGNANO.**

IT IS THE ONLY REVIEW, which has a really international collaboration
IT IS THE ONLY REVIEW, of absolutely world-wide circulation
IT IS THE ONLY REVIEW, occupying itself with the synthesis and unification of knowledge, which deals with the fundamental questions of all the sciences: history of the sciences, mathematics, astronomy, geology, physics, chemistry, biology, psychology and sociology.

IT IS THE ONLY REVIEW, which by means of enquiries among the most eminent scientists and writers on: The philosophical principles of the various sciences; The most fundamental astronomical and physical questions of current interest; The contribution given by the various countries to the different branches of knowledge; The question of vitalism; The social question; The great international questions raised by the world war, makes a study of the most important questions interesting scientific and intellectual circles throughout the world.

Abbot - Arrhenius - Ashley - Bayliss - Beichmann - Benes - Bigourdan - Bohlin - Bohn - Bonnesen - Borel - Bottazzi - Bouty - Bragg - Brillouin - Bruni - Burdick - Carracido - Carver - Castelnuovo - Caullery - Chamberlin - Charlier - Ciamician - Claparède - Clark - Costantin - Crommelin - Crowther - Darwin - Delage - De Martonne - De Vries - Durkheim - Eddington - Edgeworth - Emery - Enriques - Fabry - Findlay - Fisher - Foà - Fowler - Fredericq - Galeotti - Golgi - Gregory - Guignebert - Harper - Hartog - Heiberg - Hinks - Hopkins - Iñiguez - Innes - Janet - Jespersen - Kapteyn - Karpinski - Kaye - Kidd - Knibbs - Langevin - Lebedew - Lloyd Morgan - Lodge - Loisy - Lorentz - Loria - Lowell - MacBride - Matruchot - Maunder - Meillet - Moret - Muir - Pareto - Peano - Pearl - Perrin - Picard - Pigou - Plans - Poincaré - Puiseux - Rabaud - Reuterskjöld - Rey Pastor - Righi - Rignano - Russell - Rutherford - Sagnac - Sarton - Sayce - Schiaparelli - Scott - See - Seligman - Shapley - Sherrington - Soddy - Starling - Stojanovich - Struycken - Svedberg - Tannery - Teixeira - Thalbitzer - Thomson - Thorndike - Turner - Vinogradoff - Volterra - Von Zeipel - Webb - Weiss - Westermarck - Wicksell - Willey - Xénopol - Zeeman - Zeuthen and more than a hundred others.

"Scientia" publishes its articles in the language of its author, and joins to the principal text a supplement containing the French translation of all articles that are not in French. *(Write for a Specimen Number to the General Secretary of "Scientia", Milan, sending, simply to defray postal and other expenses, 2 francs in stamps of your country.*

ANNUAL SUBSCRIPTION: $10, post free. **OFFICE: 43 Foro Bonaparte, Milan (Italy)**
General Secretary: Doct. PAOLO BONETTI.

May be ordered from the authorized agents in the United States:

WILLIAMS & WILKINS COMPANY
Publishers of Scientific Journals and Books
MOUNT ROYAL and GUILFORD AVENUES, BALTIMORE (Maryland, U. S. A.)

Abstracts of Bacteriology

Comprising complete reviews and abstracts of American and foreign work in Bacteriology, Mycology and Protozoology in their relation to the arts and sciences

Under the editorial direction of the
SOCIETY OF AMERICAN BACTERIOLOGISTS

EDITOR
A. PARKER HITCHENS

Published Monthly. One volume a year at present. About 500 pages to a volume

Price, net postpaid: $5.00, United States, Mexico, Cuba; $5.25, Canada; $5.50, other countries

Subscriptions are received for the volume only. Single copies are not sold

Back Volumes, Vols. I–IV, incl. Price, net postpaid: $24.00, United States, Mexico, Cuba; $25.00, Canada; $26.00, other countries

---

Subscription Order for the Abstracts of Bacteriology

WILLIAMS & WILKINS COMPANY
MOUNT ROYAL AND GUILFORD AVENUES,
BALTIMORE, MD., U. S. A.

_____ 19____

I / We } enclose { $5.00 (U. S.–Canada) / $5.50 (foreign) } for subscription to the present volume of ABSTRACTS OF BACTERIOLOGY.

Name_____
(Please state whether Dr., Prof., etc.)

Address_____

INFORMATION FOR SUBSCRIBERS AND CONTRIBUTORS

THE JOURNAL OF DAIRY SCIENCE is devoted to the discussion of general and technical problems in the field of dairy science, including such phases as dairy bacteriology, dairy chemistry, nutrition, butter making, market milk, cheese making, ice cream manufacture, condensed milk and milk powder, dairy cattle breeding problems, dairy engineering, dairy management, dairy economics and such other problems as are of vital importance to the dairy industry. This authoritative journal is of vital interest to dairy instructors, investigators, inspectors, and manufacturers, as well as to students in all phases of dairy work.

THE JOURNAL OF DAIRY SCIENCE is issued bi-monthly, appearing in January, March, May, July, September and November. Each volume will consist of approximately 500 pages. Subscription is by the volume only and not by the year. One volume a year is issued at present.

Twenty-five reprints without covers of articles will be furnished gratis to contributors when ordered in advance. A table showing cost, with an order slip is sent with proof.

Manuscripts should be typewritten and carefully revised before submission and should be sent to Prof. J. H. Frandsen, Department of Dairy Husbandry, University of Nebraska, Lincoln, Nebraska.

Correspondence concerning business matters should be addressed to WILLIAMS & WILKINS COMPANY, Publishers of Scientific Journals and Books, Mount Royal and Guilford Avenues, Baltimore, U. S. A.

1922 Volume: Volume V, $5.00, United States, Mexico, Cuba; $5.25, Canada; $5.50, other countries. Prices are net, postpaid. *Foreign subscriptions to the current volume accepted at par of exchange.*

Back Volumes: Volumes I–IV, incl., $24.00, United States, Mexico, Cuba; $25.00, Canada; $26.00, other countries. Prices are net, postpaid. *Foreign subscriptions to the back volumes accepted at the current rate of exchange.*

Subscriptions are received:

For Argentina and Uruguay: Beutelspacher y Cia., Sarmiento 815, Buenos Aires.

For Australia: Angus & Robertson, Limited, Sydney; Stirling & Co., 317 Collins St., Melbourne.

For Belgium: Henri Lamertin, 58 Rue Coudenberg, Bruxelles.

For the British Empire, except Australia and Canada: Order from any British bookseller or order direct from the Publishers

For Canada: Wm. Dawson and Sons, Ltd., 87 Queen Street, East, Toronto, Canada.

For Denmark: H. Hagerup's Boghandel, Gothersgade 30, Kobenhavn.

For France: Emile Bougault, 48 Rue des Ecoles, Paris.

For Germany: R. Friedländer & Sohn, Buchhandlung, Carlstrasse 11, Berlin NW. 6.

For Holland: Scheltema & Holkema, Rokin 74–76, Amsterdam.

For Japan and Korea: Maruzen Company, Ltd. (Maruzen-Kabushiki-Kaisha) 11 to 15 Nihonbashi Tori-Sanchome, Tokyo; Fukuoka Osaka, Kyoto, and Sendai, Japan.

For Spain: Ruiz Hermanos, Plaza de Santa Ana, 13, Madrid.

For the United States and all other countries except as above: WILLIAMS & WILKINS COMPANY, Mount Royal and Guilford Avenues, Baltimore, U. S. A.

Claims for copies lost in the mails will not be allowed unless such claims are received within thirty days (domestic), ninety days (foreign) of the date of issue. Claimants must state directly that the publication was not delivered at their recorded address. The publishers will not be responsible for loss due to change of address unless notification is received at least two weeks in advance of issue.

LOUIS F. NAFIS

has specialized for 23 years in making

SCIENTIFIC GLASSWARE FOR TESTING MILK AND ITS PRODUCTS

2mm Test Bottle

Nafis Improved Dividers

Nafis Curved Point Pipette

He and his associates have studied the problem from the scientific and the practical sides—from the standpoint of the manufacturer and the user.

He has never tried to make the cheapest testing glassware but has bent every effort to make the *best*, knowing that in the long run the *best* is the *most economical* to the user.

The name **NAFIS** is a guaranty of **ACCURACY—QUALITY—&—ECONOMY.**

If your dealer does not stock NAFIS GLASSWARE write for our catalog and names of our distributors in your territory.

LOUIS F. NAFIS, INC.,

Manufacturers of Scientific Glassware for Testing Milk and its Products

542-548 Washington Blvd. **CHICAGO, Ills.**

ASK THE MAN WHO USES IT

DIFCO

BACTERIOLOGICAL REAGENTS "DIFCO-STANDARDIZED"

Recommended for use in the Bacteriological Analysis of Dairy Products

Bacto Peptone — Bacto Agar — Bacto Dextrose
Bacto Beef — Bacto Gelatin — Bacto Lactose
Beef Extract—Bacteriological

DEHYDRATED CULTURE MEDIA "DIFCO-STANDARDIZED"

The principal Formulae of the A. P. H. A. "Standard Methods"

Bacto Nutrient Agar — Bacto Nutrient Broth
Bacto Lactose Broth

As well as numerous other well recognized formulae, are manufactured in Dry Form, needing only to be dissolved and sterilized to make culture media ready for use.

Send for our descriptive bulletins and price lists on these and other specialties. "Difco" products are carried in stock by the principal dealers in Scientific Supplies.

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the research and production of Bacto-Peptone and Dehydrated Culture Media

DIGESTIVE FERMENTS COMPANY
DETROIT, MICHIGAN, U. S. A.

THE STANDARD FOR NEARLY FORTY YEARS

TRADE MARK

Paterson Vegetable Parchment

"Nearest to Perfection"

Nearly forty years ago we were making Vegetable Parchment.

One does not specialize for nearly forty years without coming very close to Perfection.

The Paterson Parchment Paper Co.

Passaic, New Jersey